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ROBERT HAGELSTEIN

1870–1945

LATE HONORARY CURATOR OF MYXOMYCETES, NEW YORK BOTANICAL GARDEN

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(WITH PORTRAIT)

A review of the life-work of Robert Hagelstein may be treated in three phases. The first—an active business career—commenced in early manhood, culminated in voluntary retirement in middle life from the management of a successful mercantile concern, to pursue for twenty years full-time scientific studies. This business career yielded the competence that permitted him freedom to devote his full time to the second and third phases, respectively his studies of the diatoms and of the myxomycetes.

It is interesting to recall from personal observation during years of association, the effect of business training in his approach to scientific study. A well developed habit of work was evident to all who came in contact with him. He had retired not to relax, though many business men find in scientific pursuits a relaxation from the stress of business. Rather, he retired to start a new career in which he set himself objectives that were pursued on a schedule as rigid as any in business. In business he constantly dealt with figures whereby he acquired a mathematical ability that enabled him to solve rapidly and mentally all of his microscopical

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measurements. More than in anything else his business training was noticeable in the action of his mind in dealing with intricate problems, requiring the sorting and evaluating of facts to arrive at sound conclusions. This ability was reflected not only in his taxonomic work but in his participation in the administration of the affairs of scientific societies.

His interest in science was practically lifelong. Minerals early held his attention. Soon he shifted to the microscope and microscopical biology. Association with the Department of Microscopy of the Brooklyn Institute of Arts and Sciences specialized further his pursuits along these lines and broadened his acquaintanceship with others scientifically minded. With the decline of the Department of Microscopy, he and many of his associates transferred their activities to the ranks of the New York Microscopical Society and greatly assisted in the resurgence of the Society at the time of the First World War. In 1921 he became its Vice-President and in 1923 and 1924 served as President. Not long after came his retirement from business. Science ceased to be an avocation and became a full time occupation.

For some years the diatoms had been foremost in his microscopical studies and he was rapidly accumulating an outstanding collection of diatom slides.[1] He had been interested particularly in the diatoms of Long Island and had collected extensively in that area. However, an opportunity afforded him by Dr. Nathaniel Lord Britton to participate in the Scientific Survey of Puerto Rico and the Virgin Islands caused him to concentrate for several years on the study of the diatoms of that region with collecting trips for diatom material in the years 1926, 1928 and 1929. Further years were spent in the completion of his report and its publication was delayed during the depression until 1939.

His interest and activities in the diatoms ran concurrently, for a number of years, with a developing and growing interest in the myxomycetes. At first, a few short papers were published, commencing in 1927, including one describing two new species. By 1935, after he had finished his diatom manuscript and devoted six months of continuous work to the indexing of his large collection of diatom slides, he was able to concentrate fully on the myxomy-

[1] Journal of The New York Botanical Garden 41: 278. December, 1940.

cetes. As with the diatoms, his early study centered mostly on the myxomycetes of Long Island, with some collecting in Puerto Rico and other islands. In 1936 his "Critical Study of the Mycetozoa of Long Island" appeared and there followed over a period of years a numbered series of "Notes on the Mycetozoa." With the growing abundance of observations entering into these "Notes," he decided to make available to students of this group of organisms, an orderly summary of his years of study into which he had put the best of his energies and critical ability. Happily in 1944 he saw this summary take the form of his book, "The Mycetozoa of North America, based upon the specimens in the Herbarium of The New York Botanical Garden." This was the culmination of the third and final phase of his life-work. There he stated frankly his opinions based on keen and conscientious observation, presented with full pride in that this voluntarily imposed task had been discharged to the best of his ability.

Apart from, but having its association with his scientific research, was his curatorship of the myxomycete collections of The New York Botanical Garden. Here again his early-formed habit of work was a force that carried him through a complete survey of the collections, not once but several times, with detailed microscopical study of sporangia and spores of the specimens. In addition the entire collection received full and personal attention as to labelling, boxing, and arrangement. Following his appointment in 1930, more than fifteen years found him working on these collections, of which ten years were devoted to the myxomycetes alone.

Though he devoted long hours of work to the myxomycetes in his laboratory at home and at the Botanical Garden, he also spent extended periods on tour, collecting from Quebec to Florida and in the islands of the West Indies south to Trinidad. His first years of intensive collecting, on Long Island, were succeeded by equally intensive and even more experienced collecting in northeastern Pennsylvania. Of the 285 species included in his book, 269 are in the collections of The New York Botanical Garden. Of these, 216 were studied by him in the field. The remarkable collecting partnership formed early with Joseph Henri Rispaud, his constant field companion, had been of the utmost assistance to him in this work. The forays that he conducted each year in

June and September on Long Island under the auspices of The Torrey Botanical Club, in coöperation until 1940 with the New York Microscopical Society, for the purpose of introducing the myxomycetes to initiates, were occasions of inspiration to those attending.

When the Cryptogamic Herbarium of The New York Botanical Garden was installed on the third floor, a room was assigned to the groups that had held his special interest, the myxomycetes and the diatoms. In this room were placed and incorporated in the Botanical Garden collections, the results of his years of collecting of the myxomycetes. Here also he placed his large and comprehensive collection of diatoms. The room was formally opened on January 11, 1941.

Mr. Hagelstein was born in New York on May 16, 1870. Later he lived in Brooklyn and from there moved to Mineola, Long Island, a move which placed him within a few minutes' automobile ride of the famous kettle hole that for years supplied his best collecting until he started going to Pennsylvania and other more distant localities. Still within easy distance of his well loved collecting spot he passed away at Mineola on October 20, 1945.

His scientific affiliations were The New York Botanical Garden, the Mycological Society of America, in whose annual forays he took a very active part, The New York Microscopical Society, Torrey Botanical Club, New York Academy of Sciences, American Microscopical Society, Royal Microscopical Society, and Queckett Microscopical Club.

THE NEW YORK BOTANICAL GARDEN
BRONX PARK, NEW YORK

BIBLIOGRAPHY

1. Mycetozoa from Porto Rico. Mycologia **19**: 35–37. Jan.–Feb. 1927.
2. An interesting discovery of a rare slime-mold. Mycologia **19**: 315–316. Nov.–Dec. 1927.
3. New Mycetozoa from Long Island. Mycologia **21**: 297–299. *pl.* 26. Sept.–Oct. 1929.
4. Mycetozoa from Jones Beach State Park. Mycologia **22**: 256–262. Sept.–Oct. 1930.
5. Revision of the Myxomycetes. Scientific Survey of Porto Rico and the Virgin Islands. New York Academy of Sciences **8**: 241–248. Nov. 22, 1932.

6. The Garden's collection of historical microscopes. Journal of The New York Botanical Garden **34**: 9–13. Jan. 1933.
7. An Adirondack Myxomycete. Mycologia **27**: 86–88. *figs.* 1–3. Jan.–Feb. 1935.
8. Albert Mann, 1853–1935. Science **81**: 308–309. March 29, 1935.
9. New and rare Mycetozoa from Long Island. Mycologia **27**: 374–375. *pl.* 34. July–Aug. 1935.
10. The Mycetozoa. New York Microscopical Society Bulletin **1**: 1–4. February 1936.
11. On preparing an exhibit of the life cycle of the Mycetozoa. Journal of The New York Botanical Garden **37**: 140–145. June 1936.
12. A critical study of the Mycetozoa of Long Island. Mycologia **28**: 547–622. Nov.–Dec. 1936.
13. Collecting excursions for Myxomycetes. Journal of The New York Botanical Garden **38**: 112–114. May 1937.
14. Notes on the Mycetozoa—I. Mycologia **29**: 392–407. July–Aug. 1937.
15. Common species of the Mycetozoa. Torreya **38**: 25–41. Mar.–Apr. 1938.
16. Notes on the Mycetozoa—II. Mycologia **30**: 336–353. May–June 1938.
17. The Diatomaceae of Porto Rico and the Virgin Islands. Scientific Survey of Porto Rico and the Virgin Islands. New York Academy of Sciences **8**: 313–450. *pls.* 3–9. January 19, 1939.
18. Notes on the Mycetozoa—III. Mycologia **31**: 337–349. May–June 1939.
19. *ibid.* IV. Mycologia **32**: 376–387. May–June 1940.
20. *ibid.* V. Mycologia **33**: 294–309. May–June 1941.
21. A new species of Mycetozoa. Mycologia **34**: 116–118. Jan.–Feb. 1942.
22. Notes on the Mycetozoa—VI. Mycologia **34**: 248–262. May–June 1942.
23. Mycetozoa: A new combination. Mycologia **35**: 130–131. Jan.–Feb. 1943.
24. Notes on the Mycetozoa—VII. Mycologia **35**: 363–380. May–June 1943.
25. William Codman Sturgis. Mycologia **36**: 123–124. Portrait. Mar.–Apr. 1944.
26. The history of the microscope. New York Microscopical Society Bulletin **2**: 1–19. *figs.* 1–11. April 1944.
27. The Mycetozoa of North America, based upon the specimens in The New York Botanical Garden. *pp.* 1–306, *pls.* 1–16. Published by the author. Mineola, N. Y. 1944.

THREE NEW ZOÖPAGACEAE SUBSISTING ON SOIL AMOEBAE

CHARLES DRECHSLER [1]

(WITH 6 FIGURES)

Three additional members of the family Zoöpagaceae have recently come to light in Petri plate cultures in which miscellaneous microörganisms introduced with decaying plant material were given prolonged opportunity to develop on maizemeal-agar medium overgrown with *Pythium* mycelium. All three forms were found subsisting on amoebae, one of them attacking the animals after the manner of an endoparasite, through germination of ingested spores, while the other two attack in a predaceous manner, by capturing the protozoans through adhesion to mycelial hyphae. Apart from descriptions of these new species, supplementary comment is herein supplied relative to an amoeba-capturing form I presented earlier under the binomial *Stylopage rhabdospora* (**3**: 374–377).

A SPECIES OF COCHLONEMA PRODUCING WARTY AZYGOSPORES

The new endoparasitic fungus made its appearance in many maizemeal-agar plate cultures that after being permeated with mycelium of *Pythium arrhenomanes* Drechsl. had been further planted with small quantities of friable vegetable detritus consisting mainly of partly decayed cucumber (*Cucumis sativus* L.) leaves and partly decayed lilac (*Syringa* sp.) leaves. The particular lot of vegetable detritus here in question was gathered near Greeley, Colorado, in October 1944, and has received mention in an earlier paper (**9**) as a source of the nematode-capturing basidiomycetous form I described under the binomial *Nematoctonus haptocladus*. Often, indeed, the amoeba parasite was found developing abundantly in the same cultures with *N. haptocladus*, its presence being betrayed

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by scattered aerial tufts of ascending conidial chains readily detectable to microscopical examination carried out with a dry objective. As under such examination the sporiferous tufts closely resembled those of both *Cochlonema symplocum* Drechsl. (**6**: 258–266) and *C. euryblastum* Drechsl. (**7**: 283–289), closer scrutiny was necessary to determine whether one of these species or possibly some allied form was active here in destruction of animal life. Accordingly, portions of the cultures were removed and examined under a water-immersion objective of high magnification. Though the conidiiferous tufts disintegrated badly in the moist preparations, they clearly had their origin in parasitized amoebae referable manifestly to a single species which in normal condition, as also in the earlier stages of attack, varied in diameter between 60 and 100 μ when drawn into a rounded shape (FIG. 1, *A–C*; FIG. 2, *A, B*; FIG. 3, *A*). Its firm, thickish pellicle, cast into broadly undulating or more delicately rippled folds, surrounded a colorless, somewhat dispersedly granular sarcode within which could be distinguished a single prolate ellipsoidal nucleus, 20 to 25 μ long and 13 to 20 μ wide, that contained normally a slightly darker, globose or prolate central body, about 8 to 11 μ wide (FIG. 1, *A–D, n*; FIG. 2, *B, n*; FIG. 3, *A, n*; FIG. 4, *A, n*). The animal endured infection with much fortitude, continuing its pseudopodial locomotion and the operation of its contractile vacuole (FIG. 1, *A–D, v*; FIG. 2, *A–B, v*; FIG. 3, *A, v*) until most of its contents were expropriated. Often its cytoplasm revealed a variable number of digestive vacuoles which sometimes were filled with massed bacteria (FIG. 1, *A, w*; *C, w*; *D, w*; FIG. 3, *A, w–z*) and sometimes contained a clump of spores (FIG. 1, *B, w*) belonging evidently to a mucoraceous fungus; such ingested spores being, however, more usually found imbedded individually here and there in the sarcode, without noticeable vacuolar development (FIG. 1, *A–D*; FIG. 3, *B*; FIG. 4, *A*). From its morphology the animal was assigned to *Amoeba verrucosa* Ehrenb.—to the same species, therefore, earlier found preyed upon by *Dactylella tylopaga* Drechsl. (**2**) and parasitized both by *C. megalosomum* Drechsl. (**4**: 128–137) and by *C. symplocum*.

As has been intimated, attack on the animal is always found initiated by germination of ingested conidia; the individual spore,

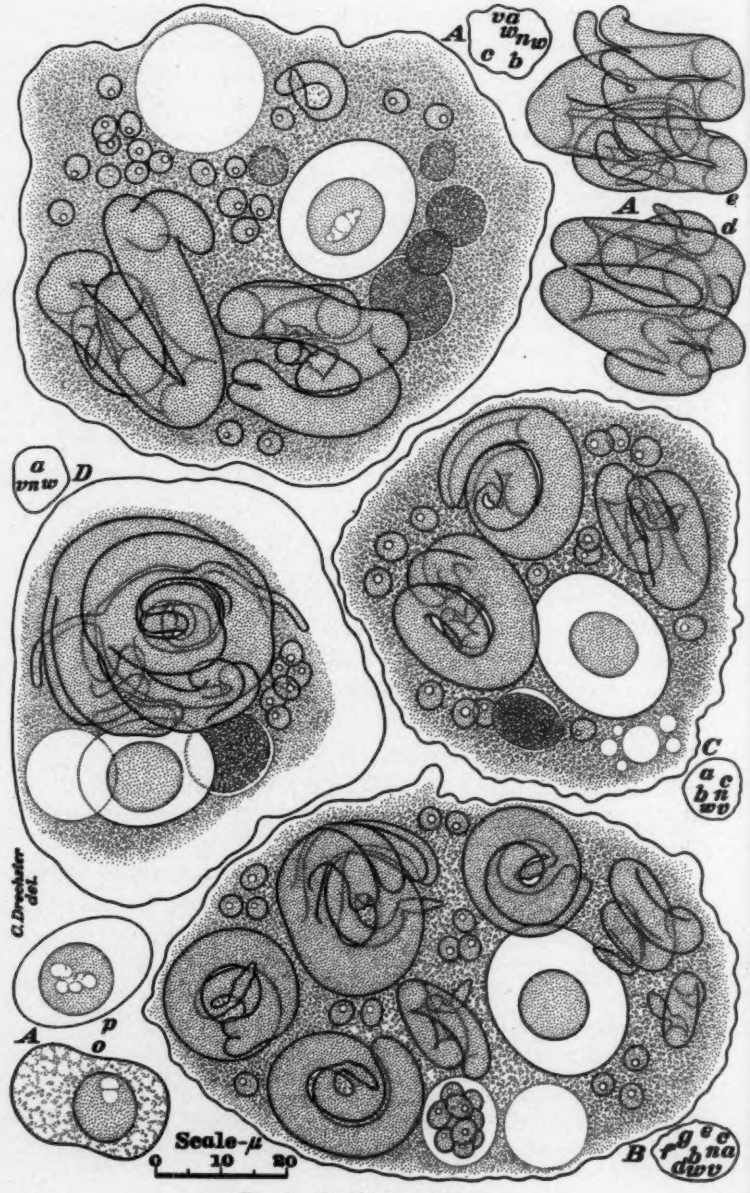

FIG. 1. *Cochlonema agamum*

soon after its ingestion, giving rise somewhat obliquely from one of its ends to a germ tube, which then prolongs itself into a thallus by feeding on the ambient host cytoplasm. In respect to the manner of establishing itself, the fungus thus shows general parallelism with *Cochlonema symplocum* and *C. euryblastum* rather than with *C. megalosomum*. Despite this parallelism and the similarity of host relationship, the young growing thallus is soon distinguishable from correspondingly young thalli of *C. symplocum* not alone by reason of its noticeably greater proximal width but also by reason of its more strongly flaring conformation (FIG. 1, *A*, *a*; FIG. 2, *A*, *a–d*); though on the other hand, it shows generally no close approach to the very stout proximal attachment and abrupt widening so conspicuous in the thallus of *C. euryblastum*. A strong tendency toward curvature becomes manifest early, and soon leads to a somewhat snail-like coiling which because of its geometrical regularity appears much more suggestive of *C. euryblastum* than of *C. symplocum*. The thallus maintains its unbranched condition during a rather extended period of elongation (FIG. 1, *B*, *a–d*; FIG. 2, *A*, *d–m*, *o*; *B*, *a–i*), but after describing 1½ to 2 spiral turns it usually bifurcates a first time (FIG. 1, *B*, *e*, *f*; *C*, *a–c*; FIG. 2, *A*, *p*; *B*, *j–m*, *o*, *p*); a second dichotomy taking place after growth of the two branches has augmented the coil in some instances by a half turn (FIG. 1, *A*, *b*, *c*) and in other instances by only one-tenth of a turn (FIG. 1, *B*, *g*). Where the four branches resulting from a second dichotomy have opportunity for substantial elongation, a third dichotomy often ensues (FIG. 1, *A*, *d*, *e*; *D*, *a*); this being followed, under appropriate conditions, by a fourth dichotomy in some, if not in all, of the terminal elements (FIG. 3, *A*, *a*; *B*). The thalli with three or four successive bifurcations usually have a volume in a general way commensurate with the number (8 to 16) of their terminal branches; for although the tertiary and quaternary branches are for the most part too narrow and too short to contribute much bulk in themselves, their production is accompanied usually by rather marked increase in width (and possibly also in length) of the proximal trunk as well as of the primary and secondary branches.

Since the eventual size of a thallus is determined by the quantity of host protoplasm available for assimilation, maximum dimensions

are attained especially in instances where only a single thallus is present in an individual animal (FIG. 1, *D*; FIG. 3, *A*, *B*). Such instances of unitary infection are not infrequent when the fungus first begins its development in a culture. Later, as conidia become strewn about more and more abundantly, they are ingested in increasing numbers, with the result that many animals will then be found harboring more than a dozen thalli (FIG. 2, *A*, *B*); and the eventual size of the thalli will be reduced proportionately.

Regardless of whether one or several conidia have been engulfed, growth of the parasite for a considerable period seems to work no injury on the animal other than progressive reduction of its cytoplasmic contents. Usually the cytoplasm will have been reduced to about a quarter of its original volume before the nucleus begins to look abnormal either from excessive vacuolization of the central body or from mottling of the peripheral layer. There is reason to believe that under suitable circumstances an animal host can recover as long as nuclear degeneration has not gone beyond an incipient stage. After the drawing reproduced in figure 1, *A*, had been prepared, the infected amoeba shown therein was kept under observation 6 hours longer at a temperature close to 23° C. During these 6 hours all three of the thalli (FIG. 1, *A*, *a–c*) within the animal continued growing actively, so that the host cytoplasm, already reduced to about one-half of its original mass when observations were begun, suffered further reduction to about one-fourth or one-fifth of its original mass, while the outer layer of the nucleus became rather conspicuously mottled (FIG. 1, *A*, *o*). The preparation was then stored overnight at a temperature of 15° C. Evidently the lower temperature greatly benefited the amoeba, for 16 hours later its contractile vacuole was again operating briskly, and the outer layer of its nucleus again presented a clear homogeneous appearance (FIG. 1, *A*, *p*). The thalli of the parasite, on the other hand, had not only failed to continue growing, but gave evidence of debility in a noticeably vacuolated condition of their contents.

Where no environmental change intervenes in behalf of the infected amoeba its dwindling sarcode sooner or later becomes incapable of further locomotion. Thereupon the fungus promptly puts forth reproductive filaments even though the host nucleus (FIG. 1, *D*, *n*) may yet present a normal appearance; so that the

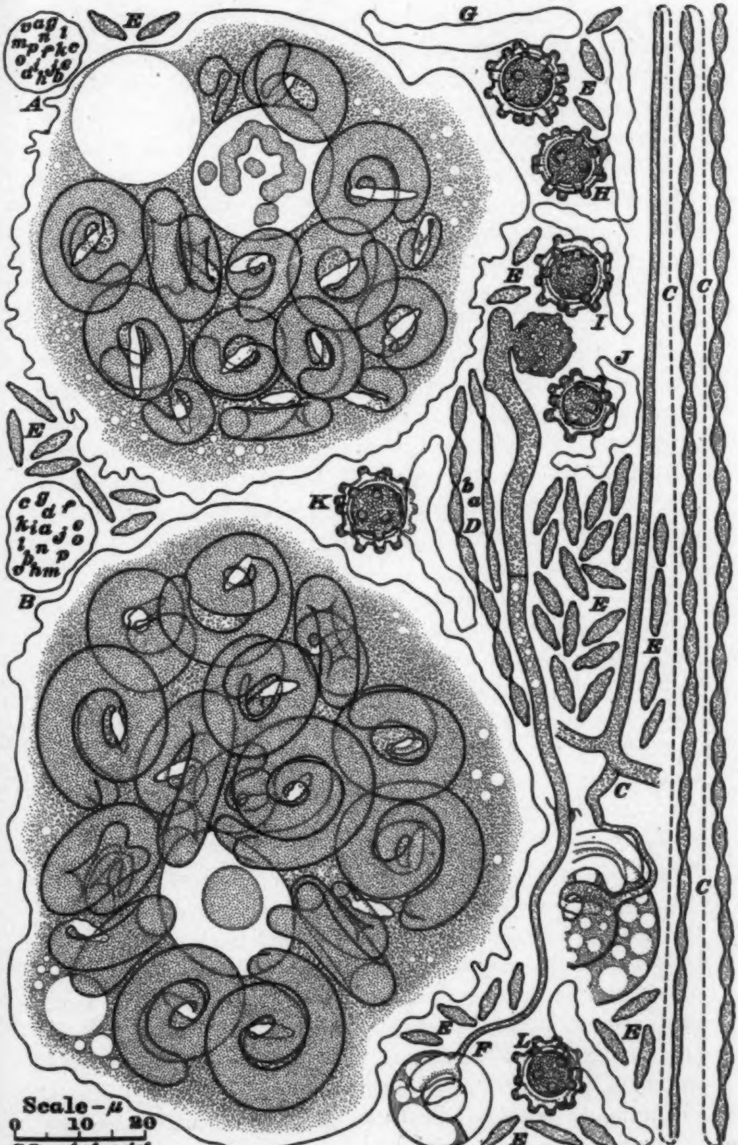

FIG. 2. *Cochlonema agamum*

final stages in the extinction of the animal's life and in the expropriation of its contents are accomplished simultaneously with the earlier stages in the reproduction of the parasite. The filaments growing from the thalli are scarcely half as wide as those of *Cochlonema euryblastum*. Generally the smaller thalli, including unbranched and once-dichotomous specimens together with some twice-dichotomous specimens, will put forth only a single reproductive filament, usually from a position on the convex side 3 to 10 μ from the parent conidium (FIG. 2, *F*; FIG. 3, *C*, *a*, *b*, *c*, *e*, *f*; FIG. 4, *A*, *a–e*). Some thalli of greater size, with 2, 3, or 4 successive bifurcations, will put forth two reproductive filaments (FIG. 1, *D*, *a*; FIG. 3, *C*, *d*, *g*; *D*, *a*, *b*), the second one arising beyond the first and often about a half turn from the origin of the coiled structure. Thalli of still larger size are found provided with three reproductive filaments (FIG. 3, *B*, *a–c*); the third one arising from a position a quarter turn beyond the second. The presence in one observed instance of an additional outgrowth (FIG. 3, *B*, *d*) suggests that the largest thalli may, perhaps, at times give rise to four reproductive hyphae.

When an infected animal succumbs on the surface of an agar culture held under ordinary conditions of storage—right side up, and with exposure to weak or moderate illumination mainly from above—all the reproductive filaments invariably make their way to the ceiling of the host pellicle. The direction of their growth is evidently not governed by chance, for where the coils of the parent thallus or of some other thallus are in the way, as is frequently the case, the filaments take a circuitous course around the interposed structures (FIG. 3, *D*, *a*, *b*; FIG. 4, *A*, *b*). They soon push out through the ceiling of the pellicle, and after widening rather markedly, extend a few procumbent branches over the upper surface of the amoeba. Where reproduction is exclusively asexual these branches do not attain any considerable length; yet since they are usually present in some number and are concentrated in a rather small area on top of the animal, they become intermingled into a loose overlying meshwork (FIG. 3, *C*). From the meshwork is sent up a tuft of 15 to 25 conidiiferous hyphae (FIG. 3, *C*, *h–z*) similar to the aerial tufts whereby the fungus was first detected; the individual reproductive filament contributing usually two or

three conidiiferous hyphae, though if the parent thallus is small (FIG. 3, *C*, *a*) it may supply only one such hypha (FIG. 3, *C*, *h*).

In its proximal portion the conidiiferous hypha shows no special modification, but beginning at a height of 25 to 100 μ constrictions appear together with minute warty irregularities (FIG. 2, *C*). Thence upward for a distance of about 50 μ the constrictions become progressively more pronounced and occur at diminishing intervals, while concomitantly the warty irregularities become more numerous and somewhat more prominent. Beyond the transitional region of increasing modification the hypha is prolonged with constrictions at equal intervals and with equal display of warty sculpturing (FIG. 2, *C*; FIG. 3, *C*, *h*, *j*, *o*, *q*, *s*, *v*). After the hypha has attained definitive length, its modified portion is converted into a conidial chain through evacuation of contents from the middle of each constriction, followed by deposition of a wall at both ends of each empty isthmus (FIG. 3, *C*, *i*, *m*, *n*, *p*, *r*, *t*, *u*, *z*); the number of spores delimited in a chain varying commonly between 25 and 65. An aerial filament that has given rise to one chain (FIG. 3, *C*, *k*, *x*) may grow out below the proximal conidium to produce a second sporogenous hyphal element (FIG. 3, *C*, *l*, *y*). Such successive development would seem more frequent where very large thalli are concerned in reproduction than with thalli of moderate size, and, of course, is wholly absent where a thallus is too small to produce more than a single conidial chain. As might be expected, the several lowermost conidia originating from the transitional portion of an aerial hypha are longer, narrower, and smoother (FIG. 2, *D*, *a*) than the generality of their fellows that come from the more distal, better differentiated hyphal portions (FIG. 2, *D*, *b*). On slight disturbance the mature conidial chains break up, leaving the disarticulated spores (FIG. 2, *E*) strewn about on the substratum ready to be ingested by any specimen of *Amoeba verrucosa* visiting the seeded area. In size and shape the conidia differ little from those of *Cochlonema symplocum*.

When an infected animal succumbs in a submerged position the reproductive hyphae, after pushing through the host pellicle, find their way to the surface of the substratum by rather widely divergent paths; wherefore the aerial conidial apparatus produced by them is not aggregated in a luxuriant tuft but is dispersed over an

extensive area as multiple floccules, each composed of 1 to 3 conidial chains. Such scattered sporulation presumably corresponds no less truly to the normal development of the fungus than tufted sporulation. What would seem, in contrast, to represent thoroughly abnormal behavior is often observable when reproductive filaments are put forth from thalli that are undergoing microscopical examination; for these filaments then consistently make their way to the floor rather than to the ceiling of the host pellicle. Manifestly this curious misdirection of growth results from positive phototropic response to the wholly unnatural upward illumination usual with vertical microscopes. As similar perversion has been noted frequently in congeneric forms, all development of reproductive filaments taking place from thalli directly under microscopical observation should be mistrusted.

Apart from asexual reproduction by conidia the fungus shows an equivalent of sexual reproduction in its frequently abundant formation of azygospores. While, as in related fungi, lower temperatures seem in some degree to favor development of the more durable spores, the two types of reproduction are often closely associated; both conidia and azygospores originating not only from the same animal host, but from the same thallus and even from the same reproductive filament. In instances where an infected amoeba has succumbed on the surface of the substratum azygospore development is initiated, like conidial formation, by extension from the thalli (FIG. 4, *A*, *a–e*) of reproductive filaments that make their way to the upper part of the animal, and then push out through the ceiling of the pellicle, to give rise, after widening rather markedly, to a few (2, 3, or 4) stout prostrate branches (FIG. 4, *A*, *k–m*, *q–z*); or if the thallus is of small size the reproductive filament may continue growth without branching (FIG. 2, *F*). The prostrate branches or prolongations grow out, often somewhat crookedly, to a length of 50 to 125 μ, and thus come to extend some distance into the material underlying or surrounding the animal. Through continued gradual widening they acquire typically an elongated clavate shape. A cross-wall is now laid down usually about 40 μ from the tip. The terminal cell thereby delimited soon burgeons forth a globose body laterally; the new excrescence more often arising from a position near the tip of the cell, or between the

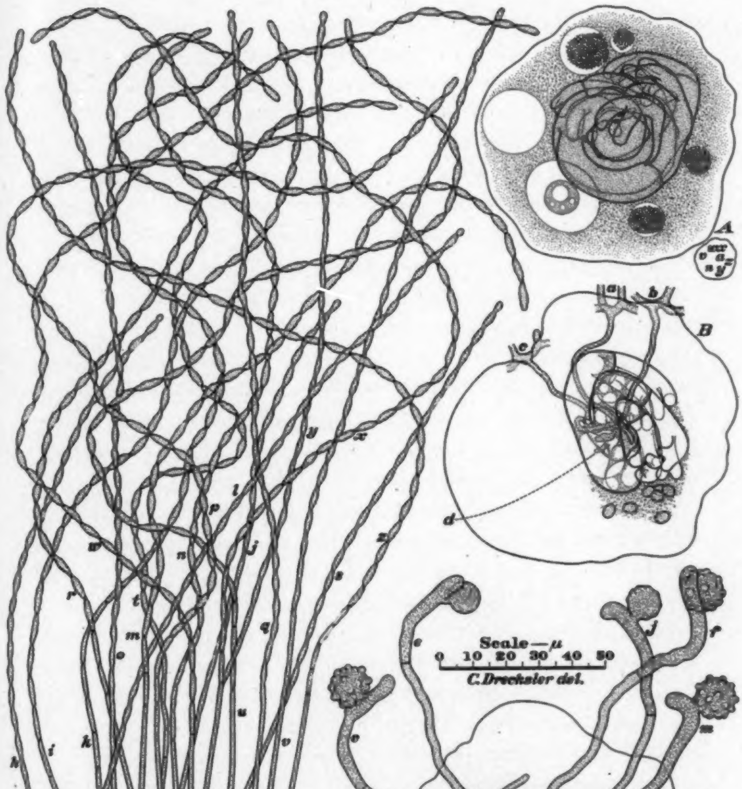

FIG. 3. *Cochlonema agamum*

middle and the tip (FIG. 2, *F*; FIG. 3, *D*, *c–h*, *j–m*; FIG. 4, *B–J*), than from a position at or slightly below the middle (FIG. 3, *D*, *i*; FIG. 4, *K*). Terminal development of the globose body, either on the tip of the cell (FIG. 4, *L*) or on a recognizable stalk of lateral origin (FIG. 4, *H*), would seem, like branching of the cell (FIG. 4, *K*, *L*), to occur as a departure from the usual. Although the distal cell here is larger than the young gametangia of most Zoöpagaceae whose sexual reproduction has been observed, it probably receives a considerable quantity of protoplasm from below after its delimitation; for, as a rule, when the distal cell has contributed all its contents to the globose body, the proximal portion of the branch similarly appears empty (FIG. 4, *C*, *J*, *L*). In the later stages of its growth the globose body becomes beset with prominent verrucose protuberances. At maturity these protuberances seem largely filled with material of a consistency uniform with the thickened peripheral wall from which they arise (FIG. 2, *G–L*). Often the peripheral wall appears spatially separated from an approximately equally thick membrane surrounding the spherical living protoplast within (FIG. 2, *G–L*); though often, again, the separateness of layers is very indistinct, and the appearance offered is more nearly that of a spherical protoplast surrounded by a thick, homogeneous, yellowish, verrucose wall (FIG. 4, *M–T*). The protoplast is evidently composed, in large part, of densely granular material. Further details regarding its internal make-up could not be ascertained because of the serious optical difficulties resulting from the presence of the numerous protuberances.

The boldly sculptured globose bodies, or azygospores, are formed in slightly submerged positions even when the protozoan host has succumbed on the surface of the substratum. In instances where the amoeba has succumbed below the surface, the zygophoric branches, unlike the reproductive filaments concerned in asexual reproduction, show no special tendency to grow upward, but produce their spores rather indiscriminately all around the animal and at no great distance from the pellicle. Once the animal's contents have been nearly exhausted, the migration of fungous protoplasm necessary to sustain continued development of azygospores, or of conidia, entails progressive evacuation of the thalli—a process accompanied here, as in several congeneric forms, by deposition of

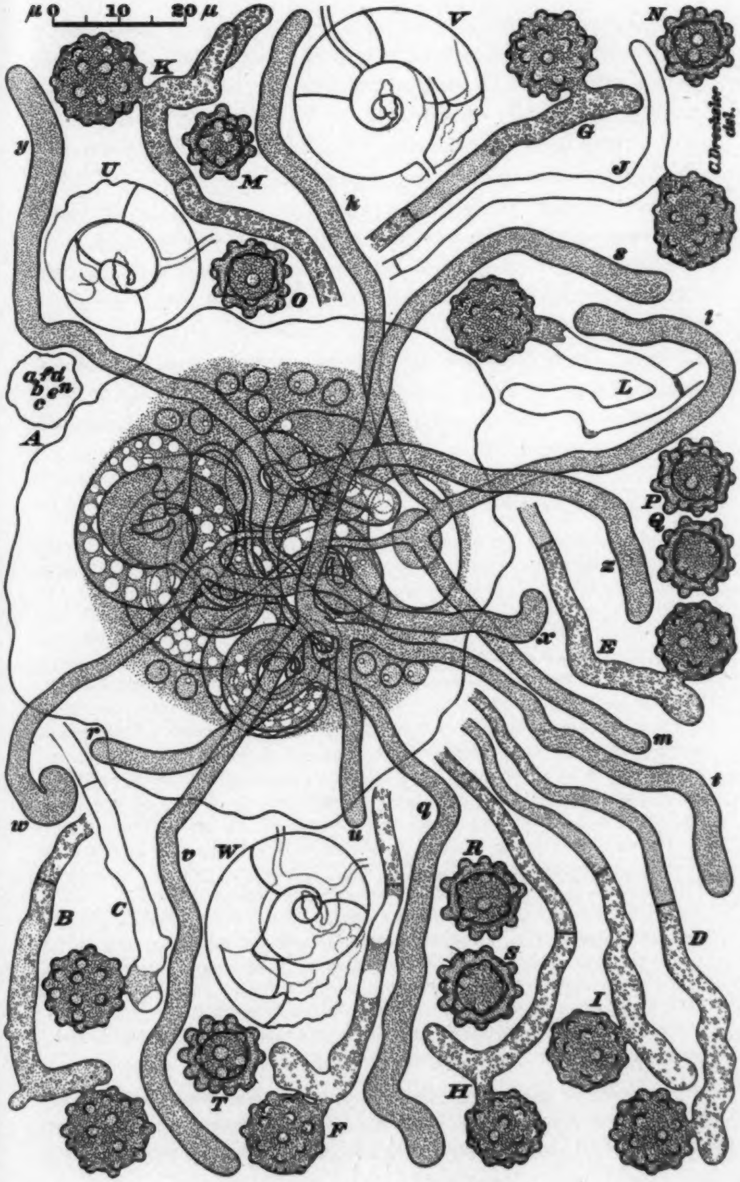

FIG. 4. *Cochlonema agamum*

retaining walls (FIG. 2, *F*; FIG. 3, *B*; *C*, *a–g*). Usually only a single transverse wall will be formed in a small thallus, while eight partitions may be laid down in a large one. Empty thalli of moderate size frequently contain three or four cross-walls (FIG. 4, *U–W*). After some time the empty thallodic envelopes, beginning in the distal portion, progressively collapse and evanesce; and when the host pellicle likewise disappears only a cluster of 10 to 35 azygospores remains as evidence of the animal's destruction.

The absence of conjugation in the development of its more durable reproductive bodies distinguishes the fungus most decisively from *Cochlonema symplocum*. Since similar reproduction is not known to occur elsewhere in the genus, except possibly in the optically difficult species I described earlier as *C. pumilum* (**5**: 398–402; **8**: 9–14), an epithet meaning "unmarried" may be appropriately suggestive.

Cochlonema agamum sp. nov.

Hyphae assumentes ex tubo germinationis circa 1 μ crasso in modum cornus latescentes, incoloratae, primo continuae, 4–13 μ crassae, usque 175 μ longae, in spiram cochleatim semel vel bis vel subinde paene ter volutae, nunc simplices nunc semel usque quater dichotomae, prope originem ex latere convexo 1–3 fortasse rarius 4 hyphas genitabiles emittentes; hyphis genitabilibus 1–1.5 μ crassis, animali debilitato vel moribundo pelliculam ejus saepe praecipue in parte superiore perforantibus, denique nunc ex aliquot ramis brevibus (1–30 μ longis) procumbentibus 1–4 hyphas conidiiferas in aerem emittentibus nunc 1–4 hyphas azygosporiferas in materiam subjacentem vel ambientem proferentibus. Hyphae conidiiferae incoloratae, erectae vel ascendentes, sursum in catenulas 25–65 conidiorum abeuntes, quandoque ex apice partis inferioris sterilis 25–100 μ longae repullulantes, denique quoque aliam catenulam gignente; conidiis incoloratis, cylindraceis vel elongato-ellipsoideis vel fusiformibus, plerumque minute verrucosis, 6–11 μ longis, 1.5–2.5 μ crassis. Hyphae azygosporiferae incoloratae, vulgo aliquantum pravae, saepius 50–125 μ longae, basi 2–2.5 μ crassae, sursum leniter latescentes, apice 3.8–5.8 μ crassae, primo continuae mox septo in duas cellulas divisae; cellula ulteriore 33–63 μ (saepius circa 40 μ) longa, subinde ramosa, ex latere vulgo prope apicem subinde medio azygosporam gignente; azygospora flavida, globosa, 9–12.5 μ (saepius circa 10 μ) diametro, 20–35 verrucis 2–2.5 μ diametro ornata, globulum protoplasmatis 6–7.5 μ diametro circumdante.

Amoebam verrucosam necans habitat in foliis plantarum (*Cucumeris sativi*, *Syringae* sp.) putrescentibus prope Greeley, Colorado.

Assimilative hyphae colorless, originally continuous, arising from a germ tube about 1 μ thick, widening out in the manner of a horn, mostly 4 to 13 μ in greatest transverse diameter, up to 175 μ long,

coiled in a snail-like spiral consisting of one to two and one-half turns, often simple, but when better developed bifurcate or two to four times successively dichotomous, putting forth from the convex profile near the proximal end one to three (sometimes possibly four) reproductive filaments which after disablement of the animal host push through its pellicle often mostly on the upper side, either to give rise from several short prostrate branches to aerial conidiiferous hyphae in numbers usually from one to four, or to extend one to four zygophoric branches into the underlying or surrounding material. Conidiiferous hyphae colorless, erect or ascending, at maturity terminating in a chain of 25 to 65 conidia, sometimes growing out from the tip of a sterile proximal part 25 to 100 μ long and giving rise to a second conidial chain; conidia colorless, cylindrical, elongate-ellipsoidal or spindle-shaped, nearly always minutely verrucose, mostly 6 to 11 μ long and 1.5 to 2.5 μ wide. Zygophoric branches colorless, usually somewhat crooked, commonly 50 to 125 μ long, 2 to 2.5 μ wide at the base, widening out gradually to a diameter of 3.8 to 5.8 μ near the apex, at first continuous, later divided by a cross-wall into two cells; the distal cell 33 to 63 μ (mostly about 40 μ) long, occasionally branched, producing an azygospore laterally sometimes from a median position but much more often from a position closer to the apex; azygospores yellowish, subspherical, studded with 20 to 35 warty protuberances 2 to 2.5 μ wide, exclusive of these protuberances measuring 9 to 12.5 μ (commonly about 10 μ) in diameter, at maturity surrounding a globose protoplast 6 to 7.5 μ in diameter.

Parasitizing *Amoeba verrucosa* it occurs in decaying leaves of *Cucumis sativus* and *Syringa* sp. near Greeley, Colorado.

AN AMOEBA-CAPTURING FUNGUS PRODUCING CONIDIA CRESTED WITH APPENDAGES

Aside from the decaying material that yielded *Cochlonema agamum,* reference was made in my account of *Nematoctonus haptocladus* to a second lot of vegetable detritus likewise collected near Greeley, Colorado, in October 1944. In this second collection, consisting mainly of partly decomposed remnants of tamarisk leaves, cottonwood leaves, and oleaster leaves, *N. haptocladus* was never found accompanied by the endoparasite just described, but instead occurred a few times in association with an equally new predaceous member of the same family. The new predaceous form came to light in 3 maizemeal-agar plate cultures 14 days after

pinches of the decaying mixture had been superimposed on an established mycelium of *Pythium undulatum* Petersen *sensu* Dissmann; its presence being detected when microscopical explorations carried out with a dry objective revealed a sparse scattering of conidia whose general similarity to the conidia of my *Acaulopage tetraceros* (**1**: 195–197; **7**: 289–291) was relieved by readily noticeable differences pertaining to the number and size of their empty appendages.

On examining under higher magnification several tracts of substratum over which these conidia were distributed only one kind of predaceous mycelium was found present. The hyphae of this mycelium had affixed to them numerous delicately wrinkled empty membranous envelopes measuring 10 to 20 μ across (FIG. 5, *A*, *a–e*; *B*, *a–d*; *C*), together with some smooth-contoured envelopes usually only about 2.5 μ in diameter (FIG. 5, *B*, *e*, *f*). It is problematical whether the envelopes of the latter sort came from active individuals of some very minute species of *Amoeba,* or whether they belonged to motile spores of some less familiar type of protozoan; they could, in any case, have held only meager nourishment for the hyphae to which they were fastened. The more capacious wrinkled envelopes unquestionably were pellicles of amoebae referable presumably to a single species. In some instances, where a substantial portion of the protoplasmic contents still remained (FIG. 5, *B*, *a*; *C*), a globose or ellipsoidal structure, measuring 2.5 to 3 μ in its greatest dimension and containing a slightly darker central body within its hyaline outer layer, appeared to represent a solitary nucleus. Expropriation of the animal's contents was accomplished by a basally branched haustorium consisting, as in *Acaulopage tetraceros,* of assimilative elements approximately equal in width to the mycelial filaments (FIG. 5, *C*).

Connection between the submerged amoeba-capturing mycelium and the appendaged conidia on the surface of the agar substratum was less clearly observable than might have been desired. Development of the conidia evidently entailed here, just as in congeneric forms, evacuation of long stretches of filament; and since the empty membranes soon became indiscernible, the hyphal attachments (FIG. 5, *D*, *E*) of the spores could not often be followed backward as much as 25 or 50 μ. Nevertheless, it seems fairly certain that two

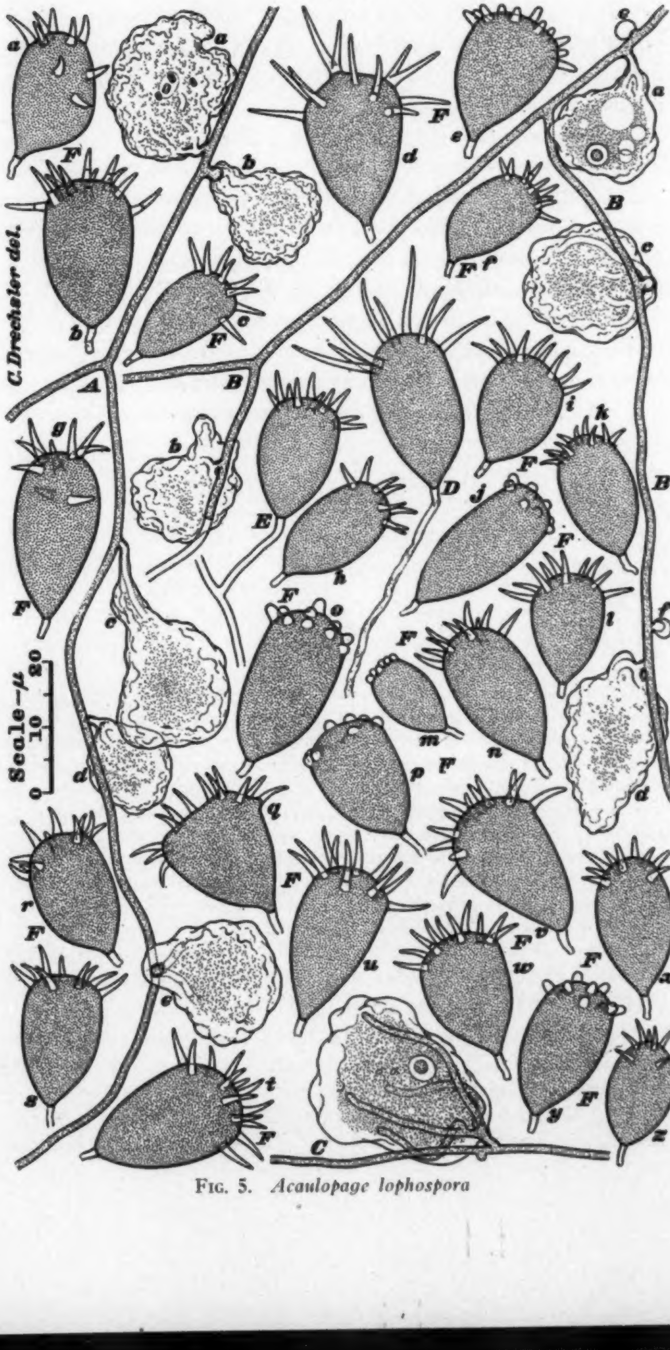

FIG. 5. *Acaulopage lophospora*

developmental states must have belonged together, because no other predaceous mycelium, and no other spores at all suggestive of the Zoöpagaceae, were to be found then or later in the same tracts of substratum.

As has been intimated, the conidia (FIG. 5, *F*, *a–z*) in a general way resembled those of *Acaulopage tetraceros* with respect to size and shape; and, moreover, were similarly provided at the base with a short stipe-like empty hyphal part. At the apical end, however, they bore commonly from 8 to 15 empty appendages, while in *A. tetraceros* the number of such parts ranges usually from 3 to 6. Their appendages, though more numerous, were, on the whole, scarcely half as long as those of *A. tetraceros,* sometimes, indeed, being reduced to wart-like protuberances (FIG. 5, *F*, *e*, *j*, *m*, *o*, *p*, *y*). In *A. tetraceros* the appendages are regularly borne in a circle around the crown of the spore, whereas in the conidia under consideration they were more often found distributed all over the distal end in a bristling crest. An epithet compounded partly of a word meaning "crest" may therefore perhaps be helpful in distinguishing the fungus producing these conidia from the congeneric form most similar to it.

Acaulopage lophospora sp. nov.

Mycelium sparsum; hyphis filiformibus, incoloratis, primum continuis, parce ramosis, plerumque 1–1.5 μ crassis, ad animalia minuta inhaerentibus, pelliculam cujusque capti perforantibus, haustorium intus evolventibus quod protoplasma exhaurit; haustorio plerumque ad instar arbusculae ex 3–4 ramulis assumentibus 5–25 μ longis et circa 1.2 μ crassis constante. Conidia in superficie materiae animalia ambientis singulatim oriunda, hyalina, basi stipitata, apice 8–15 appendicibus praedita: cellula viventi subinde inversum oviformi vel ellipsoidea sed saepius inversum lageniformi, plerumque 13–25 μ longa, 8–15 μ crassa; stipite vacuo, 2–4 μ longo, .9–1.4 μ crasso; appendicibus vacuis, vulgo acute subulatis, 3–13 μ longis, basi .8–1.5 μ crassis, subinde obtuse conicis vel verruciformibus, 1.5–3 μ longis, .8–1.5 μ crassis.

Amoebas plerumque 10–20 μ latas capiens consumensque habitat in foliis plantarum (specierum *Syringae, Populi, Tamaricis*) putrescentibus prope Greeley, Colorado.

Mycelium sparse; vegetative hyphae filiform, colorless, sparingly branched, originally continuous, mostly 1 to 1.5 μ wide, adhering to minute animals, perforating the pellicle of each captive and intruding a haustorium to appropriate the protoplasmic contents; haustorium bushlike, often consisting of 3 or 4 assimilative branches

5 to 25 μ long and about 1.2 μ wide. Conidia formed singly on the surface of the material surrounding the animals, colorless, stipitate at the base and provided at the apex with 8 to 15 appendages: the living cell sometimes obovoid or ellipsoid but more often inversely flask-shaped, usually 13 to 25 μ long and 8 to 15 μ wide; the stipe empty, mostly 2 to 4 μ long and .9 to 1.4 μ wide; the appendages empty at maturity, usually acutely awl-shaped, 3 to 13 μ long and .8 to 1.5 μ wide at the base, but sometimes bluntly conical or wart-like, then mostly 1.5 to 3 μ long and .8 to 1.5 μ wide.

Capturing and consuming amoebae, mostly 10 to 20 μ wide, it occurs in decaying leaves of *Syringa* sp., *Populus* sp., and *Tamarix* sp., near Greeley, Colorado.

AN AMOEBA-CAPTURING FUNGUS PRODUCING CONIDIA BESET WITH LONGISH FINGER-LIKE APPENDAGES

A maizemeal-agar plate culture that on May 5, 1945, was planted with softened discolored roots from a wilting pansy (*Viola tricolor* L.) plant newly dug up in Mt. Rainier, Md., showed, when explored microscopically 21 days later, sparsely scattered conidia beset with bristling appendages in a manner reminiscent of the amoeba-capturing fungus I described earlier (**7**: 274–278) as *Acaulopage lasiospora.* On closer examination it was found that the conidia in question were, on the whole, appreciably smaller than those of *A. lasiospora,* and that they more frequently tapered noticeably toward the proximal end (FIG. 6, *A*, *a–x*), thereby acquiring more often a somewhat turbinate shape. Their appendages showed marked distinctiveness in that they were longer than the appendages of *A. lasiospora,* and only about half as numerous.

At the time the conidia first came under observation the mycelium from which they originated was for the most part already empty of contents, making it very difficult to trace the slender hyphae for any distance. Unfortunately, besides, *Acaulopage tetraceros* was present in considerable abundance throughout the culture, so that when membranous remains of amoebae were found affixed to mycelial elements it was usually not possible to ascertain which fungus had been concerned in particular instances of capture. Details relating to haustorial development must consequently await an accession of less ambiguous material. In the meantime the

curious conidial ornamentation would seem to justify amply the recognition in the Zoöpagaceae of an additional member to be known by a specific epithet compounded of two words meaning "porcupine" and "seed," respectively.

Acaulopage hystricospora sp. nov.

Mycelium sparsum, parce ramosum; hyphis incoloratis, primo continuis, circa 1 μ crassis, ad animalia minuta inhaerentibus, pelliculam cujusque capti perforantibus, haustorium intrudentibus quod protoplasma exhaurit. Conidia in superficie materiae animalia ambientis singulatim oriunda, incolorata vel subinde languide flavida, globosa vel elongato-ellipsoidea vel applanato-ellipsoidea vel turbinata, plerumque 7.5–12.5 μ longa, 7–14 μ crassa, basi interdum minute stipitata, prope basin semper glabra, medio interdum glabra interdum appendicibus vestita, apice semper appendicibus vestita; appendicibus in summa 10–50, in maturitate vacuis, digitiformibus, plerumque 2–6.5 μ longis, .7–.9 μ crassis.

Amoebas capiens consumensque habitat in radicibus *Violae tricoloris* putrescentibus in Mt. Rainier, Maryland.

Mycelium sparse, sparingly branched; vegetative hyphae colorless, originally continuous, about 1 μ wide, capturing minute animals through adhesion, perforating the pellicle of each captive, and extending into it a haustorium to appropriate the protoplasmic contents. Conidia produced singly on the surface of the material underlying or surrounding the animals, colorless or sometimes faintly yellowish, globose or prolate ellipsoidal or oblate ellipsoidal or turbinate, mostly 7.5 to 12.5 μ long and 7 to 14 μ wide, sometimes minutely stipitate, always glabrous in the region surrounding the hilum, glabrous or beset with appendages in the equatorial zone, regularly beset with appendages at the distal end; the appendages commonly numbering 10 to 50 in all, empty at maturity, finger-shaped, mostly 2 to 6.5 μ long and .7 to .9 μ wide.

Capturing and consuming amoebae, it occurs in decaying roots of *Viola tricolor* in Mt. Rainier, Maryland.

A STRAIN OF STYLOPAGE RHABDOSPORA PRODUCING LARGISH CONIDIA

Many of the cultures that, after being planted with the cucumber-lilac detritus from Colorado, yielded *Cochlonema agamum*, often in association with *Nematoctonus haptocladus*, permitted abundant development also of *Stylopage rhabdospora*. On the whole the Colorado strain showed satisfactory agreement with the original description of the species, but its conidia, ranging in length from

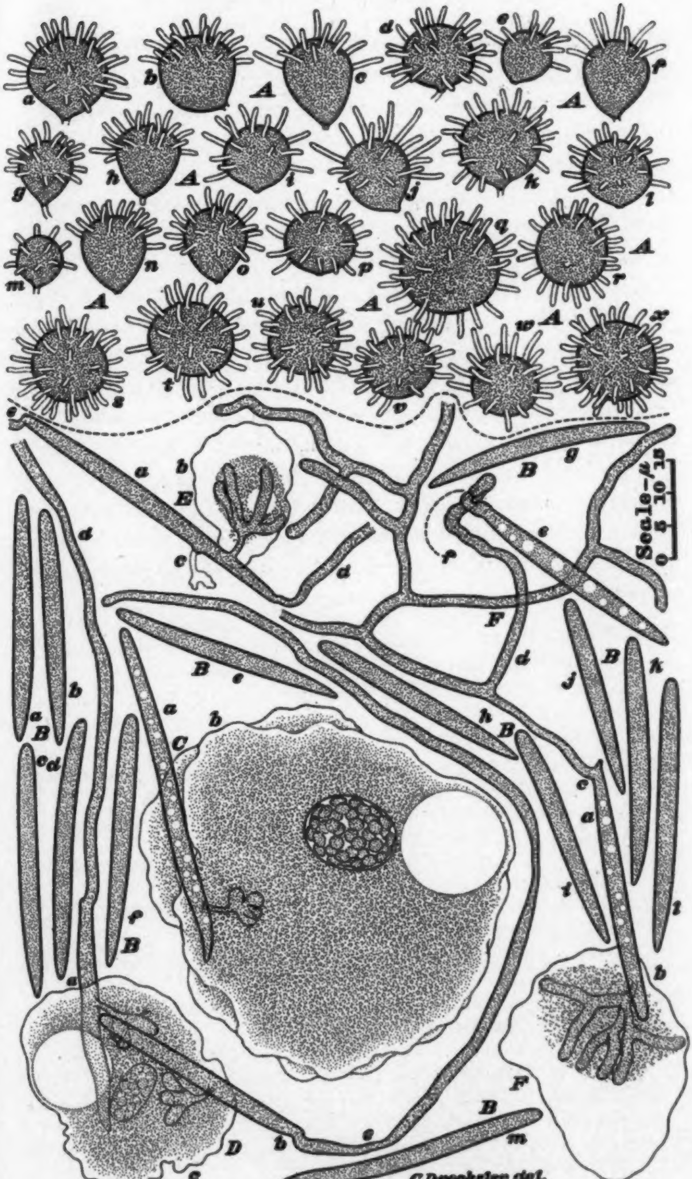

FIG. 6. A. *Acaulopage hystricospora*
B–F. *Stylopage rhabdospora*

30 to 52 μ, and in width from 2.7 to 3.2 μ (FIG. 6, *B*, *a–m*; *C*, *a*; *D*, *a*, *b*; *E*, *a*; *F*, *a*, *e*), exceeded the dimensions previously given. The *Amoeba* attacked by it was manifestly of the same species as the one earlier found serving as prey, though some individuals measured no less than 50 μ when drawn into a rounded shape (FIG. 6, *C*, *b*). While the single prolate-ellipsoidal nucleus present in these larger animals measured as much as 14 μ in length and 11 μ in width (FIG. 6, *C*, *b*) it revealed, like the smaller nuclei figured earlier (**3**: p. 375, FIG. 4, *A*, *C*), about 30 to 35 oblate ellipsoidal bodies distributed peripherally; about 10 to 12 of the bodies being usually visible in profile view. The larger animals as well as the smaller ones (FIG. 6, *D*, *c*; *E*, *b*; *F*, *b*) were often attacked directly by adhering conidia, which in such instances would intrude a haustorium while at the same time putting forth one (FIG. 6, *D*, *d*, *e*; *F*, *c*) or two (FIG. 6, *E*, *d*, *e*) germ hyphae. Again, much as in the earlier material, a hyphal branch (FIG. 6, *F*, *d*) on encountering a germ hypha from a conidium nearby (FIG. 6, *F*, *e*) would often conjugate with it (FIG. 6, *F*, *f*) to initiate development of a zygospore.

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LITERATURE CITED

1. **Drechsler, C.** Some non-catenulate conidial phycomycetes preying on terricolous *Amoebae*. Mycologia **27**: 176–205. 1935.
2. ——. A new mucedinaceous fungus capturing and consuming *Amoeba verrucosa*. Mycologia **27**: 216–223. 1935.
3. ——. New conidial phycomycetes destructive to terricolous *Amoebae*. Mycologia **28**: 363–389. 1936.
4. ——. A few new Zoöpagaceae destructive to large soil rhizopods. Mycologia **31**: 128–153. 1939.
5. ——. Five new Zoöpagaceae destructive to rhizopods and nematodes. Mycologia **31**: 388–415. 1939.
6. ——. Four phycomycetes destructive to nematodes and rhizopods. Mycologia **33**: 248–269. 1941.
7. ——. New species of *Acaulopage* and *Cochlonema* destructive to soil *Amoebae*. Mycologia **34**: 274–297. 1942.
8. ——. Several additional phycomycetes subsisting on nematodes and *Amoebae*. Mycologia **37**: 1–31. 1945.
9. ——. A clamp-bearing fungus parasitic and predaceous on nematodes. Mycologia **38**: 1–23. 1946.

EXPLANATION OF FIGURES

FIG. 1. *Cochlonema agamum;* drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A*, Specimen of *Amoeba verrucosa* still active though infected with 3 thalli, *a–c*; *d*, *e*, same thallus as *c*, but drawn 30 minutes later and 4 hours later, respectively; *n*, host nucleus in virtually healthy condition; *o*, same host nucleus 6 hours later, showing abnormal mottling in outer layer; *p*, same host nucleus, restored to virtually normal condition through incubation for 16 hours at 15° C.; *v*, contractile vacuole of host; *w*, digestive vacuoles crowded with ingested bacteria; 20 ingested spores of a mucoraceous fungus are shown scattered through the protoplasm. *B*, Specimen of *Amoeba verrucosa* still actively motile though infected with seven thalli, *a–g*, of various sizes; *n*, host nucleus; *v*, contractile vacuole containing a group of spores from a mucoraceous fungus; 14 other similar spores are shown distributed through the host cytoplasm. *C*, Small specimen of *Amoeba verrucosa* still motile though infected with three thalli, *a–c*; *n*, host nucleus; *v*, contractile vacuole, *w*, digestive vacuole containing ingested bacteria; 14 ingested spores of a mucoraceous fungus are shown scattered through the cytoplasm. *D*, Small disabled specimen of *Amoeba verrucosa* infected with a large thallus, *a*, that is putting forth two reproductive filaments; *n*, host nucleus; *v*, contractile vacuole; *w*, digestive vacuole crowded with bacteria; six ingested spores of a mucoraceous fungus are shown imbedded in the host cytoplasm.

FIG. 2. *Cochlonema agamum;* drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A*, Specimen of *Amoeba verrucosa* still capable of slight movement though infected with 15 thalli, *a–m*, *o*, *p*, mostly rather small; *n*, host nucleus abnormal in the organization of its darker material; *v*, contractile vacuole. *B*, Large specimen of *Amoeba verrucosa* still capable of slight movement though infected with 15 thalli of moderate size, *a–m*, *o*, *p*; *n*, host nucleus of virtually normal appearance; *v*, contractile vacuole. *C*, Portion of a thallus showing a reproductive filament and its connection with a young growing conidiiferous hypha; the latter from lack of space being shown in parts connected in proper sequence by broken lines. *D*, Catenated conidia as found in the proximal portion, *a*, and in a more distal portion, *b*, of a chain. *E*, Random assortment of disarticulated conidia, showing ordinary variations in size and shape. *F*, Small thallus that has yielded most of its contents in prolonging its single reproductive filament into a zygophoric hypha from whose distal cell a young azygospore has burgeoned forth laterally. *G–L*, Mature azygospores to each of which is attached the empty membrane of the distal cell.

FIG. 3. *Cochlonema agamum;* drawn to a uniform magnification with the aid of a camera lucida; × 500 throughout. *A*, Specimen of *Amoeba verrucosa* still capable of some movement though infected with a large thallus, *a*; *n*, host nucleus of nearly normal appearance; *v*, contractile vacuole; *w–z*, digestive vacuoles to a large extent crowded with ingested bacteria. *B*, Disabled specimen of *Amoeba verrucosa* whose contents have been almost completely assimilated by the large thallus, which in turn has lost most of its protoplasm in putting forth conidial apparatus from three reproductive filaments, *a–c*; a short diverticulum, *d*, evidently representing a fourth repro-

ductive filament that aborted at an early stage. *C*, Specimen of *Amoeba verrucosa* whose contents have been almost completely assimilated by seven thalli, *a–g*, which collectively have given rise to the 19 conidiiferous hyphae and conidial chains *h–z*: *a* having given rise to *h*; *b* to *i*, *j*; *c* to *k*, *l*; *d* to *m*, *n*, *o*, and to *p*, *q*; *e* to *r*, *s*; *f* to *t*; *g* to *u*, *v*, and to *w*, *x*, *y*, *z*. *D*, Specimen of *Amoeba verrucosa* killed by 2 large thalli, *a* and *b*, each of which has given rise to two reproductive filaments; the more proximal filament from thallus *a* having then produced the zygophoric branches *c* and *d*; the more distal filament from thallus *a* in like manner having produced the zygophoric branches *e*, *f*, *g*; the proximal filament from thallus *b* having produced the zygophoric branches *h*, *i*, *j*, *k*; the more distal filament from thallus *b* having produced the zygophoric branches *l* and *m*.

FIG. 4. *Cochlonema agamum;* drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A*, Specimen of *Amoeba verrucosa* disabled from infection by six thalli, *a–f*, five of which, *a–e*, have each put forth a reproductive filament that in every instance is extending zygophoric branches into the surrounding material—thallus *a* in this manner giving rise to branches *k*, *l*, *m*; thallus *b* to branches *q*, *r*; thallus *c* to branches *s*, *t*, *u*, *v*; thallus *d* to branches *w*, *x*; and thallus *e* to branches *y*, *z*; *n*, host nucleus. *B–L*, Distal portions of zygophoric branches, showing development of azygospore in various positional relationships to the terminal cell, and in two instances (*K*, *L*) showing ramification of the terminal cell. *M–T*, Detached mature azygospores, showing variations in size and sculpturing. *U–W*, Empty thalli of moderate size, with three (*U*) or four (*V*, *W*) transverse partitions, and with one (*U*, *V*) or two (*W*) reproductive hyphae; the distal portion of each thallus collapsing and evanescing.

FIG. 5. *Acaulopage lophospora;* drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A*, Portion of mycelium to which are affixed the virtually empty pellicles of five amoebae, *a–e*. *B*, Portion of mycelium to which are affixed: *a*, one moribund amoeba that still reveals a nucleus, a contractile vacuole, and a remnant of cytoplasm; *b–d*, three virtually empty pellicles of conspecific amoebae; *e*, *f*, two empty envelopes of very minute microörganisms. *C*, Portion of hypha to which is attached a moribund amoeba largely expropriated of its cytoplasm. *D*, Conidium shown attached to an empty collapsing evanescent hypha. *E*, Conidium shown attached to a short branch arising from a mycelial filament. *F*, *a–z*, Detached conidia showing variations in size and shape of the living cell, as well as in size, shape, number and arrangement of the appendages.

FIG. 6. Drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A*, *Acaulopage hystricospora:* Detached conidia, *a–x*, illustrating usual variations in size and shape of the living cell, as well as in number, size, and arrangement of the appendages; 16 of them (*a–p*) being shown as viewed at a right angle to the longitudinal axis; two (*q*, *r*) as viewed from below, with the hilum surrounded by a glabrous area; six (*s–x*) as viewed from above, with appendages arising everywhere from the apical surface. *B–F*, *Stylopage rhabdospora* (strain from Greeley, Colorado): *B*, Detached conidia, *a–m*, showing variations in size and shape. *C*, Conidium, *a*, infecting a large individual amoeba, *b*; nucleus of animal being drawn to show all the oblate ellipsoidal bodies distributed throughout its periphery.

D, Two conidia, *a* and *b*, infecting a small amoeba, *c*, while putting forth the germ tubes *d* and *e*, respectively. *E*, Conidium, *a*, that has intruded one haustorium into a small captured amoeba, *b*, besides producing and later evacuating another haustorium, *c*, while at the same putting forth two germ hyphae, *d* and *e*. *F*, Conidium, *a*, which has largely depleted a captured amoeba, *b*, by means of a haustorium, besides putting forth a germ hypha, *c*, one of whose branches, *d*, has encountered the germ tube from a neighboring conidium, *e*, and is uniting apically (*f*) with it.

STUDIES ON SOME FUNGI FROM NORTH-WESTERN WYOMING. I. PYRENO-MYCETES

Lewis E. Wehmeyer *

(with 20 figures)

During the summer of 1940, the writer spent several months at the Rocky Mountain Field Station of the University of Michigan (Camp Davis), at the mouth of Hoback Canyon, some seventeen miles south of Jackson, Wyoming. During this period, collections and observations of the fungi of this region were made within a radius of some forty or fifty miles. This area is very interesting from a mycological viewpoint. It includes the Jackson Hole area about the Snake River, the Teton National Park, with its rugged peaks, a number of other mountain ranges and a large area of high, dry, hilly sagebrush country.

At first inspection this does not appear to be a region favorable for fungus growth. However, it is of special interest in several respects. The fleshy fungi, it is true, appear to be absent over a large part of the area and during most of the year, but even these do occur, and in abundance, after the very local, but often heavy showers of late summer. To collect these one must be on the right spot at the right time—a few days after such periodic showers. Only a few such opportunities were encountered, and no great attention was paid to fleshy forms.

Parasitic fungi, such as leaf spots, rusts, etc., also abound. The region has a large and varied host flora which will yield an abundance of such parasites. Dr. Solheim's accounts and collections (**11**: pt. 1–4) have recorded many of these. A third flourishing fungous flora, and the one in which the writer was most interested, is that found on the stems of herbaceous and woody plants. The Pyrenomycetes and Fungi Imperfecti on dead stems grow luxuriantly, particularly at the higher elevations and in the mountain meadows. In these situations there is a heavy winter snow-

* Papers from the Department of Botany of the University of Michigan, no. 764.

fall which remains late in the spring, often into the early part of July. There is also a luxuriant growth of herbaceous plants in these mountain areas and a great variety of host species are represented. The dead herbaceous stems are covered and protected by heavy snow all winter and are thoroughly saturated with moisture for a long period during the spring. These conditions are ideal for the growth and maturation of stem fungi. An excellent opportunity was thus presented to make extensive collections on a wide variety of hosts and to make a comparative study of them, which it was hoped might throw light on several vexatious questions.

Some 115 collections were made on the stems of some seventy different host genera. Certain generalities stand out from the study of these collections. A number of species are usually found associated upon the same stems. Frequently as many as eight fungi (No. 1114 on *Aquilegia,* 1121 on *Agastache,* 1134 on *Linum* etc.), including pycnidial stages, were found on the same collection of stems. On the *Agastache* stems cited, five species of *Pleospora* were found. In all, 298 such "occurrences" were recorded from these 115 collections. The fruit bodies of the various species are often intricately intermingled but sometimes widely scattered. They are, in many cases, difficult to distinguish even under a binocular dissecting microscope, and the presence of a species is often discovered only after a microscopic mount has been made. This difficulty of separation no doubt explains much of the confusion in the literature concerning the interpretation of various exsiccati and type material, and makes the inclusion of careful drawings of spores and other diagnostic characters all the more important in the description of these fungi.

Likewise, such multiple occurrences indicate the dangers of interpreting genetic connections by mere association alone. Any widely distributed conidial stage, such as *Heteropatella umbilicata,* can be found associated with a wide variety of ascus stages of different species, and the reverse is likewise true of most of the ascus stages. Occasionally, a repeated association of two such stages, as the occurrence of Scolecotrichum-like conidial forms with *Mycosphaerella Tassiana,* may indicate a greater probability of their genetic relation, but does not constitute proof.

Most of the species on dead stems are common and ubiquitous

on many host genera (*Pleospora permunda, Mycosphaerella Tassiana, Heteropatella umbilicata* etc.), whereas others seem to be limited to one host genus (*Sphaerulina Gentianae, Apiocarpella* (sp.), *Pleospora* (sp.) or seem to favor certain families of hosts or certain groups of host genera (*Leptosphaeria Erigerontis, Mycosphaerella dolichospora* etc.). The most frequent genera in this region are *Pleospora, Mycosphaerella* and *Leptosphaeria* in the order named. Many species of these stem fungi are supposed to start their cycle as parasites on the living plant parts and form the ascus stage saprophytically over winter on the dead parts. Those species mentioned above as being limited as to host, may represent such restricted parasites but more extensive collections are needed, which when made often reveal a range that is much wider than might be suspected. It seems quite obvious that most of these stem fungi are not limited in their host range, and seem to develop saprophytically. Some species, as *Mycosphaerella Tassiana* and *Pleospora permunda,* can be found on almost every collection that is made. An interesting side-light on this distribution is that a species often appears in a few localities but on a number of different hosts. This was quite apparent in the study of *Pleospora,* where collections segregated on a morphological basis alone often turned out to have come from one or a few limited localities but on different hosts. It appears that a fungous species becomes established at a station and spreads readily in that area to the stems of many different higher plants.

Lying at an altitude of from 6000 to 11,000 feet, this region shows a definite arctic-alpine component in its fungous flora. Such species as *Heteropatella umbilicata, Mycosphaerella Tassiana,* many of the clathrate species of *Pleospora,* etc., are reported in almost all of the lists from localities of high altitude or latitude. There also seems to be a rather distinct component of the fungous flora of herbaceous stems which is found chiefly above 8000 to 8500 feet elevation. Too few collections have been made to be greatly significant, but all collections, for instance, of *Nectriella Pedicularis, Apiosporella alpina, A. Mimuli, Mycosphaerella dolichospora, Sphaerulina Gentianae, Heteropatella umbilicata, Sirexcipula* (sp.) and many other species, were taken from elevations of 8500 feet or above. Again, very few species were found to occur both at

the lower elevations of 6000 to 8000 feet and at the higher levels above 8000 feet. Additional collections may show other interesting relationships.

The present paper is concerned with the Pyrenomycetes (exclusive of *Pleospora* and *Leptosphaeria*) found on stems. In the course of this discussion, it will be necessary to refer to certain new species of the Fungi Imperfecti which are to be described in a following paper. Such species are referred to in parentheses, *i.e. Phoma* (sp.). The taxonomic situation in the genera *Pleospora* and *Leptosphaeria* is in such a confused condition that a special study has been made of the fairly large series of collections of these genera, and will be presented in a separate paper. Similar difficulties are found in other large genera, as *Phoma, Mycosphaerella, Septoria,* etc., where many described species are based upon their occurrence upon some host species or genus, rather than upon any morphologic distinction.

The chief localities at which collections were made are briefly described below, and are later referred to merely by these names. Inasmuch as all collections were made during the summer of 1940 and within fifty miles of Jackson, Wyoming, the year and town are omitted from collection citations. Small letters after collection numbers indicate series of species occurring on the same collection of stems.

CAMP DAVIS: Situated on flat land at about 6000 feet elevation, at the mouth of Hoback Canyon, on the Hoback River, some seventeen miles south of Jackson, Wyo. Surrounded by dry gravelly flats and foothills, covered largely with a sagebrush vegetation with abundant herbaceous growth in the richer and moister areas. Some poplar and forest growth on low hills behind the camp, elevation up to 6500 ft.

CREAM PUFF MT.: A local name for a mountain north of Camp Davis, across the Hoback River, with an elevation of 9665 ft. Most collections were taken from the upper slopes and crest, which are covered with an herbaceous flora of the alpine meadow type.

HOBACK CANYON: River flats and steep slopes along the Hoback River and ravines of tributary streams. Mostly rocky slopes with a brushy or coniferous cover and scattered small meadows. Elevation 6000–7000 feet.

GLORY MT.: Peak directly north of the Teton Pass road at its summit, consisting of steep rocky slopes, sparsely wooded. Elevation 8500 feet at the pass, 10,000 feet at the top. This slope, although exposed, is thoroughly watered by melting snow and supports a great variety of herbaceous alpine plants. Summit covered with a stunted alpine growth, with a few small meadows just below. Most collections made between 9000 and 10,000 feet.

SOUTH OF TETON PASS: This refers to a region south of Teton Pass road, which is a high ridge running southward. It consists of steep slopes and high meadows, mostly open, but in part forested with conifers, at an elevation of 8500–9500 feet. This area includes large areas of lush meadows mostly above 9000 feet which yielded many collections.

TOGWOTEE PASS: Twenty-five to thirty miles east of Moran, Wyoming. Collections were made on the slopes and summit of Breccia Peak, at an altitude of 9500 to 10,500 feet. The lower slopes are wooded or park-like, the upper slopes covered with a continuous alpine meadow with many herbaceous species.

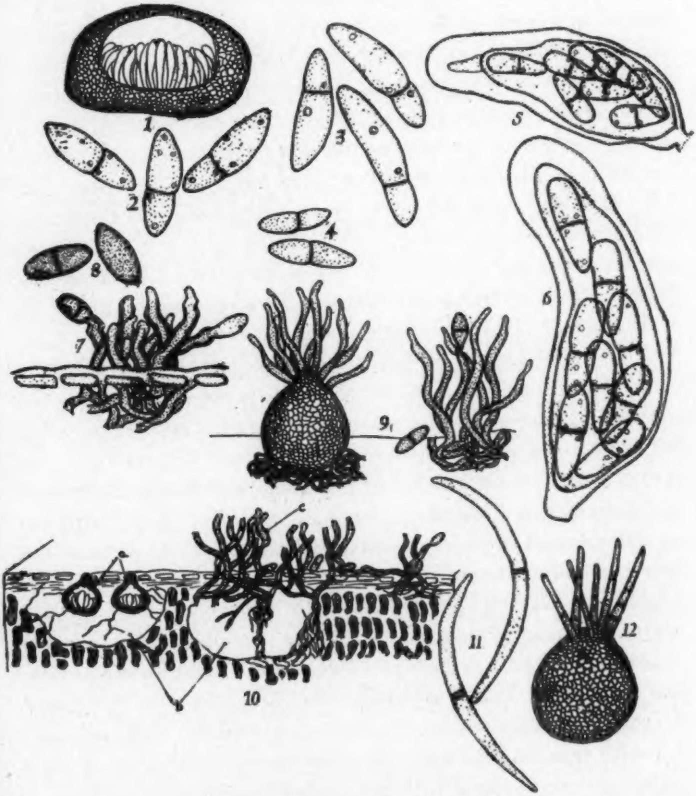
SKYLINE TRAIL: A trail leading over the high plateau behind (to the west of) the main Teton Range. Collections were made on two separate trips. The first on July 24, was on the north portion of the trail, up the south fork of Cascade Canyon. Collections were made in two high alpine meadows above timber line, at elevations of 10,500 to 11,000 feet. On August 4, a few collections were made along the southern portion of the trail on the lower wooded slopes of a branch of Death Canyon and at "Overlook," at elevations of 9000–9500 feet.

Apiosporella alpina sp. nov. (FIG. 2)

Perithecia dense dispersa, deinde erumpentia, superficialia (ab exfoliatione epidermatis), atra, nitida, depresse globosa, 250–350 μ diametro, 200–250 μ alta; pariete 30–50 μ crasso, ex parenchymate crasso, atro constituto. Asci cylindrici-clavati, 85–100 μ longi, 10–13 μ crassi, apicali membrana incrassata. Sporae biseriatae ellipsoidales vel inaequilaterales, 16–21.5 μ longae, 4.5–6 μ crassae, ad apicem attenuatae, inaequaliter bicellulae, cellula apicali breviore quam altera, 8–9 μ longa.

Specimen typicum in caulibus vetustis *Pedicularis bracteosae* Benth., prope Togwotee Pass, Teton Co., Wyoming, 8 Julii, 1940, legit L. E. Wehmeyer, sub numero 1095.

Perithecia thickly scattered, formed beneath the epidermis but soon erumpent-superficial by exfoliation of that tissue, shiny black, flattened-spheric, 250–350 × 200–250 μ, walls thick (30–50 μ), sclerotial, of dark, coarse parenchyma, sharply delimited next the



FIGS. 1–12. Wyoming Pyrenomycetes

hymenium. Asci cylindric-clavate, wall somewhat thickened at the apex, 85–100 × 10–13 μ. No paraphyses nor paraphysis-like structures were seen. Spores biseriate, ellipsoid to inequilateral, usually narrowed toward one end and with a septum excentrically placed near this end, hyaline, variable in size with maturity, 16–21.5 × 4.5–6 μ, shorter cell 8–9 μ long.

Togwotee Pass: July 8, on *Pedicularis bracteosa* Benth., leg. L. E. Wehmeyer (1095) (Type), and *P. racemosa* Dougl. (1097a).

Skyline Trail: July 24, on *Hedysarum* sp. (1173b).

Although there are no paraphyses in these perithecia, their large size suggests *Didymella* rather than *Mycosphaerella*. Saccardo erected the genus *Apiospora* for unequally two-celled forms of simple Pyrenomycetes of this type. Höhnel (**4**: 1215) claimed that the type of this genus, *A. Montagnei* Sacc., was a stromatic dothideaceous type on grasses and erected a new genus *Apiosporella* for the simple, so-called sphaeriaceous, Didymella-like species, but gave no description nor designated any type. Theissen (**13**: 275) later discussed this genus, gave a diagnosis, and chose *Apiosporella sepincolaeformis* (Sacc.) Theiss. as the type. Several species, including *Apiosporella sepincolaeformis* (*A. rhodophila* (Sacc.) Höhn.), *Didymella eupyrena* Sacc., *D. nivalis* (Fck.) B. & V., and *D. Delphinii* Earle, have spores from 15–25 × 7–9 μ which cover the range of spore size of this and the following species. These four collections of *Apiosporella* present a more or less overlapping series of spore sizes varying with degree of maturity, but seem to fall into the two species here described, which is supported by the association of a *Phoma* (sp.) with the two collections of this species on *Pedicularis* and of a *Macrophoma* (sp.) with that on *Mimulus*, if these represent conidial connection. Using this same line of reasoning, the collection on *Hedysarum* (1173b) might be considered distinct, because it is associated with an *Apiocarpella* (sp.). This *Apiocarpella*, on the other hand, is associated on another collection of *Hedysarum* (1126) with *Sphaerulina inaequalis*. All of which reveals the dangers of using such circumstantial evidence in the erection of species. Only comparison with type material can determine whether any or all of these collections are identical with the species mentioned.

Apiosporella Mimuli sp. nov. (FIGS. 1 & 3)

Perithecia dense dispersa in areis interruptis, depresse globosa, 400–500 μ diametro, atra, erumpentia, superficialia; pariete 30–50 μ crasso, crasse parenchymatoso, atro; ostiolis papilliformibus. Asci clavati, basi angustati, 90–100 μ longi, 16–18 μ crassi, pariete apicali incrassato. Sporae biseriatae, fusiformi-ellipsoideae vel asymmetricae vel paululo curvatae, inaequaliter bicellulae, hyalinae, 23–32 μ longae, 5.3–8.5 μ latae, cellula inferiore circa 10 μ longa.

Specimen typicum in caulibus vetustis *Mimuli Lewisii* Pursh, secus viam "Skyline Trail," Teton National Park, Wyoming, 24 Julii, 1940, legit L. E. Wehmeyer, sub numero 1171.

Perithecia thickly scattered locally, 400–500 μ in diameter, flattened-spheric, black, formed beneath the epidermis but soon erumpent-superficial, ostiole papillate, walls 30–50 μ thick, consisting of coarse black parenchyma. Asci clavate with a tapered base and a thickened apical wall, 90–100 × 16–18 μ. Spores biseriate, fusoid-ellipsoid to inequilateral or slightly curved, unequally two-celled, hyaline, 23–32 × 5.3–8.5 μ, lower cell about 10 μ long.

On *Mimulus Lewisii* Pursh, Skyline Trail, July 24, leg. L. E. Wehmeyer (1171) (Type).

This species differs from the preceding in the definitely larger spores. It is associated with a *Macrophoma* (sp.).

DIATRYPELLA DISCOIDEA Cke. & Pk.

On *Betula glandulosa* Michx., Camp Davis, July 4 (1080).

This collection shows the typical circular discs, long stalked asci, spore bearing portion 35–55 × 7–8 μ and allantoid spores, yellowish in mass, 3.5–5.5 × 0.8–1 μ.

Didymella Castillejae sp. nov. (FIG. 4)

Perithecia dense dispersa, superficialiter erumpentia, globosa vel paulum depressa, 200–300 μ diametro, 150–200 μ alta; ostiolo centrali, papilliformi; pariete 50–80 μ crasso, bistratoso, exteriore crasso, atro, interiore tenuiore, hyalino. Asci longe cylindrici, 55–70 μ longi, 7–9 μ crassi, membrana ad apicem incrassata; paraphysibus nullis, sed pseudoparaphyses adsunt. Sporae biseriatae fusoideo-ellipsoideae, bicellulae, hyalinae, ad septum paulo constrictae, 12.5–14 μ longae, 3.5–4.5 μ crassae.

Specimen typicum in caulibus vetustis *Castillejae miniatae* Dougl., prope Camp Davis, Jackson, Wyoming, 24 Junii, 1940, legit L. E. Wehmeyer, sub numero 1043.

Perithecia rather thickly scattered beneath the epidermis, soon erumpent, globose or somewhat flattened, 200–300 × 150–200 μ, with a central papillate ostiole and thick (50–80 μ) stromatic walls consisting of an outer layer of coarse black parenchyma and an inner thin hyaline layer. Asci long cylindric, with a thickened apical wall, 55–70 × 7–9 μ. No true paraphyses, but some interthecial tissue present. Spores biseriate, fusoid-ellipsoid, two-celled, hyaline, slightly constricted at the septum, 12.5–14 × 3.5–4.5 μ.

On *Castilleja miniata* Dougl., Camp Davis, June 24, leg. L. E. Wehmeyer (1043) (Type).

DIDYMELLA EXIGUA (Niessl) Sacc.

Perithecia scattered, formed beneath the epidermis, soon erumpent, globose to strongly flattened, 250–400 × 200–300 μ, with a central conic to strongly flattened ostiole, walls 20–40 μ thick, composed of coarse black parenchyma, asci clavate, apical wall somewhat thickened, not fasciculate, with a slight amount of interthecial tissue, but no true paraphyses, 55–70 × 9–12 μ. Spores biseriate, fusoid-ellipsoid, often inequilateral or slightly curved, two-celled, hyaline, slightly constricted at the septum, 16–19.5 × 4.3–5.5 μ.

South of Teton Pass: on *Pedicularis contorta* Benth., July 11, (1135).

Hoback Canyon: Red Creek, on *Senecio serra* Hook., July 25, (1184).

No species are described on these hosts that fit these collections, but they are nearest to *D. exigua,* described from various herbaceous hosts.

Guignardia Epilobii (Wallr.) comb. nov. (FIGS. 13 & 14)

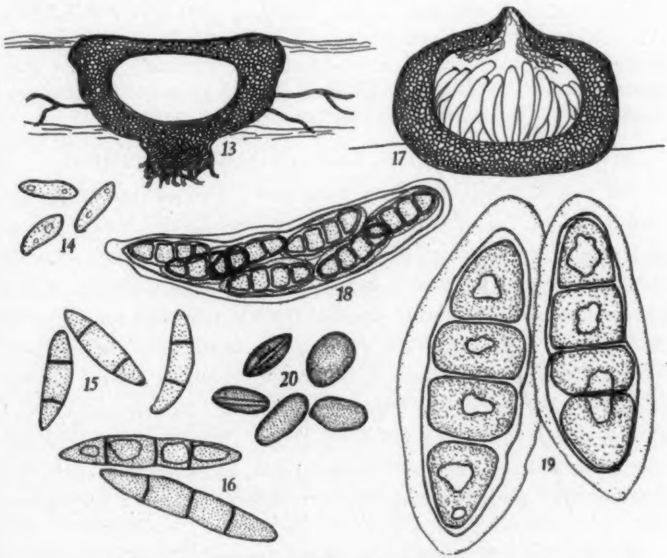
Sphaeria Epilobii Wallroth, Flora Cryptogamica Germ. **2**: 771. 1833.

Perithecia thickly scattered, on the surface as minute, black, circular, sunken, saucer-shaped spots, formed beneath the epidermis, globose, or usually with a flattened upper surface, becoming collapsed, 150–300 × 100–150 μ, with a central pore-like ostiolar rupture of the thick dothideaceous wall of dark colored pseudoparenchyma. The perithecia are often anchored in the substrate by a stromatic foot of this same tissue, 100 × 70–100 μ. Asci clavate, with a tapering base, 40–75 × 7–10 μ, wall thin, collapsing, but persistent when empty, emitted in a fasciculate group, without any paraphyses. Spores biseriate, broad fusoid-ellipsoid, one-celled, hyaline, 10–14 × 3–5.3 μ.

South of Teton Pass: on *Epilobium angustifolium* L., July 11, (1116).

This species belongs to the controversial *Laestadia-Guignardia-Gnomonina* group, whose involved historical background has been reviewed by Höhnel (**5**), Sydow (**12**) and Miller and Thompson (**9**). Miller and Thompson conclude their remarks with the following words: "The writers of this paper will follow Petrak in considering *Sphaerella Bidwellii* the type of *Guignardia,* and so re-

strict the genus to forms with uniloculate stromata, with no beak, fasciculate asci, no paraphyses and one-celled ascospores." The genus name *Guignardia* is used here in this sense. Nevertheless, the writer believes this to be a make-shift solution. He is strongly inclined to Sydow's view that Viala and Ravaz' real intentions were the substitution of the name *Guignardia* for the name *Laestadia,* and that they had no right and no intention to present *Guignardia Bidwellii* as a type, for if this species were congeneric with *Laes-*



FIGS. 13–20. Wyoming Pyrenomycetes

tadia alnea, it obviously could not be the type, and if it were not congeneric, they would obviously be erecting a new genus, with *G. Bidwellii* as a type, and not a substitute name. This view makes *Laestadia, Guignardia,* and *Gnomonina* synonymous, but leaves no name for the group here considered (including *G. Bidwellii?*). Höhnel's conclusions cannot be taken as final. He never saw *G. Bidwellii,* which is apparently not a *Phyllachorella.* A comparative study of the types of *Laestadia, Phyllachorella, Montagnellina, Haplothecium, Laestadiella* and other genera must be made before this question can be resolved.

HERPOTRICHIA QUINQUESEPTATA Wier

The ascospores of this material are light yellow-brown, 5-septate, 25–28 × 7–8 μ, and the spores and asci are identical with figures given by Wier (**14**).

Medicine Bow Mts., Laramie, Wyo.: on *Picea Engelmanni* (Parry) Engelm., June 15 (1009).

HYPODERMELLA CONCOLOR (Dearn.) Darker

Hysterothecia sunken, walls colorless, 300–400 × 200–250 μ. Asci clavate, with a tapered base, 85–110 × 14–16 μ. Paraphyses filiform, numerous. Spores clavate-fusoid, rounded at one end, tapered toward the other, 40–44 × 2.5–3.5 μ, with a gelatinous envelope 3 μ thick when first emitted from the ascus.

On *Pinus Murrayana* Balf., Camp Davis, June 17 (1004).

The association of fungi on these needles is an interesting but confusing one. The *Hypodermella* appears on the upper surface of leaves of the previous year, as small papillae, or later, as small sunken watery spots, with a minute central ostiole. These needles have dry, brown, discolored tips, but the hysterothecia are scattered on and concolorous with the green living portions. The colorless hysterothecia place this collection in the group of related species including *H. sulcigena* (Rostr.) Tub., *H. montivaga* (Petr.) Dearn. and *H. concolor* (Dearn.) Dark. It is placed in the last species because of the small hysterothecia, although the spores are smaller than given for that species (45–60 × 6–8 μ) by Darker (**2**).

On these same living needles, there occurs a *Hendersonia* (sp.) which appears to be parasitic and is very similar to *H. acicola* Münch. & Tub. It is of interest in this connection that Lagerberg's (**6**) contention that *H. acicola* is the conidial stage of *H. sulcigena* has been accepted by most European workers, whereas Darker (**2**: 56) states that "From observations made in western America on the closely related species, *H. montivaga,* the writer believes that *Hendersonia* is merely a secondary fungus following up after the disease has been initiated by the other species." Darker gives no notes of the *Hendersonia* concerned. This view of Darker's is borne out to some extent by the occurrence on the same infected needles of other fungi of a secondary nature. *Myco-*

sphaerella Hypodermellae is found on these same needles, and its conidial stage (?), a *Scolecotrichum* (FIG. 10), is found parasitizing the hysterothecia of the *Hypodermella*. In addition, a few minute pycnidia (50–70 μ in diameter) of a *Ramularia*, with long cylindric, straight to curved, 4-celled, hyaline conidia, 19–30 × 2–2.5μ were found parasitizing these same hysterothecia. It is obvious that the *Hypodermella*, which supposedly was the primary infection, so weakens the needles, that a number of secondary fungi gain entrance.

LOPHODERMIUM NITENS Darker

Glory Mt.: On *Pinus flexilis* James, June 20 (1030).

METASPHAERIA JUNCINELLA Mout. (FIG. 16)

Appearing on the stems as widely but evenly scattered, minute, black dots, which are the globose immersed perithecia, 100–200 μ in diameter, with walls 5–10 μ thick, of coarse dark pseudoparenchyma; ostiole pore-like. Asci few, saccate to broad-clavate, with a thickened wall and a claw-like base, 50–70 × 18–20 μ. Spores crowded fasciculate, cylindric, straight or slightly curved, hyaline to pale yellowish, triseptate, sometimes slightly constricted at the central septum, and often with a terminal, globose appendage when released from the ascus, 32–41 × 5–5.5 μ.

Elk Refuge, Jackson, Wyo.: on stems of *Scirpus validus* Vahl, July 1 (1071a).

This material is rather immature and it is possible that the spores may become darker in color and so place it in *Leptosphaeria*. It is very similar to *L. juncicola* Rehm. It differs from the description of *Metasphaeria juncinella*, however, only in the shorter and stouter asci, but these asci often elongate with maturity, and it is placed here until further material can be examined. The perithecia are accompanied by a *Phaeoseptoria* (sp.), which has slightly larger and more widely spaced pycnidia.

MYCOSPHAERELLA: The custom of describing species upon the basis of host occurrence leaves very little meaning to species names in this group of saprophytic stem inhabiting fungi, where host limitation has not been demonstrated.

The intention in this paper is to arrange the material in such a way that it is available for later reference, rather than to bury it

beneath the names of a number of new species or misdeterminations. To that end, the collections have been arranged in Table I according to spore size, and lines are used to separate probable species groups, the differential characters of which are elaborated upon in the text descriptions. In Table II a large number of collections, showing certain characters in common, are similarly arranged and placed under the collective species *Mycosphaerella Tassiana* (de Not.) Johans.

TABLE I

No.	Host	Spore Range	Asci	Perithecia
1067	PEDICULARIS	8–10×2–2.5	25×7	100–200
1131c	CLEMATIS	10.5–11.5×2.5	37–43×7	100–125
1112c	CARUM	10.5–16×3–3.5	35–40×7	
1113	ERIGERON	12–13×3–4	44–53×7–9	100–150
1056	AQUILEGIA	12.5–15×3–3.5		
1180	AQUILEGIA	12.5–16×3.5	36–38×11–14	100–150
1114	AQUILEGIA	16–18×3.5	45–55×9–10.5	100–150
1045a	DELPHINIUM	12.5–18×3.5–5	50–60×12.5–16	
1024a	COMPOSITE	14–18×3.5–4.5	45–53×9–11	150–200
1129	DELPHINIUM	14–18×3.5–4.3	53×10.5–12.5	150–200
1004b	PINUS	13–16×3.5–5	70–90×17–21	90–100
1072	JUNCUS	14–18×2.5–3.5	30–35×8–12	40–50
1124	CLEMATIS	22–30×2.5–3.5	50–55×12–13	100–150
1131	CLEMATIS	29–35×3–3.5	55–70×9–12	150–200
1166	CARUM	30–40×2.5–3.5	62–70×14	120–150
1026c	UMBELLIFER	32–37×3–3.5	60–75×14–15	200
1112b	CARUM	33–37×3–3.5	53–61×14–16	120–150

There is much variation as to spore size with degree of maturity, the amount of subepidermal or superficial hyphal growth, form and distribution of perithecia, etc., but it is often impossible to demonstrate any correlation with host occurrence. The separation and naming of species has, therefore, been somewhat arbitrary. Names of previously described species have been applied wherever practicable.

MYCOSPHAERELLA TASSIANA (de Not.) Johans. (FIGS. 5, 6 & 9).

Camp Davis: On *Glycerrhiza lepidota* Pursh, Snake River Canyon, July 15 (1140); *Senecio Rydbergii* A. Nels., June 19 (1033); *Commandra pallida* DC. (1011); *Heuchera Williamsii* Eaton, June 24 (1044); *Castilleja linariaefolia* Benth.,

TABLE II

No.	Host	Spore Range	Asci	Perithecia
1140	Glycerrhiza	12–16×2–5	43–68×12–14	100–150
1089a	Penstemon	12.5–14×3.5	53×17.5	
1159c	Castilleja	14–15×5	35–43×16–18	90–100
1101a	Lupinus	14–17×4.3–5.3	55–70×19–21	100–150
1015a	Castilleja	14–18×4.5–5	55–65×16–17	100–130
1119	Osmorrhiza	14–18×3.5–5	55–70×14–18	100–140
1142	Bupleurum	14–22×5–6	43–60×17–23	
1044	Heuchera	14.5–18×5–6	27–45×15–20	50–100
1115	Thalictrum	(14) 17–22×3.5–7	35–43×20–23	100–120
1022d	Umbellifer	16–18×5–6	70×10	
1032a	Syntheris	16–18×4–5.5	43–60×17–22	100–120
1126f	Hedysarum	16–18×3.5–5	43–53×11–22	
1064	Helianthella	16–19×5–5.5	50–53×10.5–18	100–150
1134d	Linum	17–19×5–6	60–70×21	150–200
1025b	Balsamorrhiza	17–20×4–5	70–80×12.5–18	100–150
1033	Senecio	17–20×5–6	50–60×19–23	100–120
1133c	Sambucus	17–20×5–6	62×21.5	
1011	Commandra	17.5–19.5×5–7	53–65×22	
1114a	Aquilegia	17–22×5–5.5	35–40×23–25	90–120
1108c	Rudbeckia	17–23×5	62×18	
1121h	Agastache	18–20×3.5–4.5	63–70×18–20	100–120
1128b	Valeriana	18–21.5×5.3–7	53–70×22	
1212	Sisyrhinchium	18–23×5.3–7	40–53×18	80–100
1100c	Helianthella	19–23×5.5–6	55–65×18–21	
1166f	Carum	19–23×7	70–78×18–26	150–200
1109	Agastache	20–22×4–5.5	70–75×17–27	100–150
1167a	Linum	21×7	97×21	80–100
1185b	Draba	21–22×5	60×17–19	100–150
1016	Penstemon	21–24×5–7	70×18	100–120
1023a	Linaria	21.5–23×5–5.5	70×23–25	
1177a	Senecio	26.5–28.5×5.5–8.5	60–70×22–26.5	150

Hoback-Snake River Junction, July 15 (1159c); *C. flava* Wats., June 18 (1015a); *Penstemon glaber* Pursh, June 18 (1016); *Sisyrinchium angustifolium* Miller, June 18 (1212); *Balsamorrhiza sagittata* (Pursh) Nutt., June 26 (1063b); *Linum Lewisii* Pursh, June 24 (1047a) and *Helianthella quinquenervis* (Hook.) Gray (1064).

Cream Puff Mt.: On *Penstemon Rydbergii* A. Nels., July 5 (1089a).

Hoback Canyon: On *Bupleurum americanum* C. & R., July 16 (1142); *Aquilegia coerulea* James, June 25 (1056b) and *Draba luteola* Greene, Red Creek, July 29 (1185b).

Glory Mt.: June 20, on *Syntheris dissecta* Rydb. (1032a); *Balsamorrhiza sagittata* (Pursh) Nutt. (1025b) and *Linaria vulgaris* Mill. (1023a).

South of Teton Pass: July 11, on *Osmorrhiza occidentalis* Torr. (1119); *Agastache urticifolia* (Benth.) Rydb. (1109 & 1121h); *Aquilegia coerulea* James (1114a); *Thalictrum occidentale* Gray (1115); *Sambucus microbotrys* Rydb. (1133c); *Pedicularis contorta* Benth. (1135a); Umbellifer stems (1022d); *Lupinus parviflorus* Nutt. (1110f & 1130c); *Rudbeckia occidentalis* Nutt. (1108c); *Hedysarum uintahense* A. Nels. (1126f); *Valeriana* sp. (1128b) and *Linum Lewisii* Pursh (1134d).

Togwotee Pass: July 8, on *Helianthella* (?) (1100c) and *Lupinus candicans* Rydb. (1101a).

Skyline Trail: July 24, on *Linum Lewisii* Pursh (1167a); *Zygadenus alpina* Blak. (1176b); *Aconitum Bakeri* Greene (1169a); *Senecio* sp. (1177a); and *Carum Carui* L. (1166f).

In Table II the spore, ascus and perithecial measurements are given of a large number of collections which form a species complex with a good deal of variation, but with certain characters in common. This represents an extremely widespread arctic-alpine species complex which has been reported under this or other binomials on a wide variety of hosts in every flora of the fungi of northern regions or high altitude. It is the most abundant species on stems in Wyoming, and scarcely a collection can be made without its yielding a representative of this group.

The perithecia are all small, 70–150 μ (rarely 200 μ) in diameter, and are globose at first, but soon become characteristically pyriform because of the formation of a rather stout conic ostiole. They may be, on the other hand, widely scattered, densely crowded or confluent, and may or may not show a blackening of the host surface. They are immersed at first but later become strongly erumpent.

The shape of the ascus is perhaps the most diagnostic character of the group. Typically, it is broadly saccate below and is contracted sharply into a narrower cylindric tip which has a much thickened wall (FIGS. 5–6). The spores are crowded in the lower broader portion. With maturity, however, the ascus may stretch and become more regularly clavate or even cylindric.

The spores are also quite variable, as can be seen from Table II. They are narrow-fusoid and slightly constricted at first, but become broader clavate or wedge-shaped, with the upper cell broad and rounded and the lower one narrower and tapered, and with no constriction. The smaller spores (below 14 μ), on *Glycerrhiza* and *Penstemon,* are immature.

The writer agrees with Lind (**7**: 164) that this is a collective species, with many synonyms, which has been reported on many hosts under many binomials. Some authors use the above binomial for the occurrences of this fungus on Monocotyledons and the name *Mycosphaerella pachyasca* (Rostr.) Vestergr. for its occurrences on Dicotyledons. Lind, however, unites the two usages under the earlier name, which seems logical until more definite information is available as to possible subdivisions of this complex.

The writer also agrees with Winter (**15**: 359) that it is difficult to draw lines between this and other species because of the variability of its characters and the overlapping variations found on a series of hosts, which is strikingly portrayed by the series in Table II.

The collection on *Heuchera,* for instance, is probably the same as *Sphaerella trichophila* (Karst.) var. *Saxifragae* Dearness of which Dearness (**3**: 346) says "This *Sphaerella* has characters connecting it with *S. minor* Karst. and *S. pachyasca* Rostr. . . . But the bristles near the vertex, the brown subiculum and the fruit characters bring it closer to *S. trichophila.*" *S. trichophila* is given as having the spores and asci of *S. Tassiana,* and the other characters mentioned are commonly associated with this species complex. No. 1119, on *Osmorrhiza* (*Glycosma*) *occidentalis,* is probably the *Mycosphaerella Glycosmae* of Tracy & Earle. *M. Washingtoniae* Rehm (**10**: 346), although reported on Palmae by Saccardo (Syll. Fung. **24**: 881), is described on *Washingtonia brachypoda* and seems to be a synonym. The large spored form, on *Penstemon,* may be *Mycosphaerella Penstemonis* Tracy & Earle.

The perithecia are often accompanied by a Scolecotrichum-like growth of upright, zigzag, septate, brown hyphae, or by scattered or densely crowded pycnidium-like sclerotia, which may be sterile perithecial primordia, and which are crowned by a fascicle of stiff,

upright, septate, brown hyphae, 3–5 μ in diameter. Either on these conidiophores, or on the setose hyphae of the sclerotia, there are borne two-celled, brown, oblong-cylindric conidia, 17–22 × 7 μ, which arise singly and sparingly at the apex of these hyphae. The hypha then grows on and produces another conidium. These conidia are very seldom seen attached, but are usually deciduous onto the host surface. In the collection on *Osmorrhiza* (No. 1119), similar setose sclerotia were seen, but here fusoid-cylindric, curved, hyaline conidia, 25–35 × 3–4 μ, and similar to those reported under *M. dolichospora,* on umbelliferous hosts, were found. Similar *Scolecotrichum* or sclerotial conidial stages were found associated with several other species of *Mycosphaerella* and seem to be characteristic of the stem forms of this genus. Their cultural connection would be of interest.

MYCOSPHAERELLA PUNCTIFORMIS (Fr.) Starb. var. CLEMATIDIS Jaap.

Perithecia minute, globose, 100–125 μ in diameter, thickly scattered on crowded, usually limited, blackened areas caused by the subepidermal growth of dark brown hyphae; ostiole stout papillate not prominent. Asci clavate, usually emitted in a ball-like fascicle, apical wall thickened, 25–43 × 7 μ. Spores biseriate, fusoid-ellipsoid, one end sometimes more rounded, two-celled, hyaline, scarcely constricted at the septum, 8–14 (16) × 2–2.5 (3.5) μ.

South of Teton Pass: July 11, on *Erigeron salsuginosus* Gray (1113), *Carum Carui* L. (1112c) and *Clematis Douglasii* Hook. (1131c).

Camp Davis: Willow Creek, June 28, on *Pedicularis groenlandica* Retz. (1067).

This is admittedly a provisional grouping of these four collections, which show small, fusoid spores, clavate asci and clustered perithecia with a development of dark colored, radiate subepidermal hyphae. There is rather a wide range of spore size, but more data are needed before these differences can be correlated for species differentiation. This variety seems to be the most similar to my collections of any described on these hosts. *M. vitalbina* (Pass.)Petr. is also similar but is described with asci inflated at the base, suggesting a young stage of *M. Tassiana. Sphaerella*

Pedicularis Karst., *S. lineata* (Clem.) Sacc. & Sacc. and *S. subcongregata* E. & E. also seem to be *M. Tassiana*. The collection on *Carum*, which has the larger spores (10–16 × 3–3.5 μ), comes closest to *Sphaerella sagedioides* Winter of any of the species described on Umbelliferae.

MYCOSPHAERELLA COERULEA (E. & E.) Tracy & Earle

Perithecia sparsely to thickly, but evenly scattered, usually with no, or very little blackening of the substratum, immersed then erumpent by a minute ostiole, black, globose, to somewhat flattened, 100–150 μ in diameter. Asci stout clavate, with a thickened apical wall, fasciculate, 35–44 × 7–14 μ. Spores biseriate, fusoid-ellipsoid, two-celled, hyaline, slightly constricted at the septum, 12.5–18 × 3–3.5 μ.

On *Aquilegia coerulea* James, South of Teton Pass, July 11 (1114); Red Creek, Hoback Canyon, July 29 (1180) and at Hoback Forest Camp, June 25 (1056).

M. coerulea is given with slightly larger spores (15–20 × 3.5–4.5 μ), but Ellis, N. A. F. No. 3522 of *Sphaerella coerulea*, is identical with these collections and shows spores 13–18 × 3.5–4 μ. This species differs from *M. Tassiana*, which occurs on the same stems, in the more evenly distributed, shiny black, more globose to depressed perithecia and the clavate asci and fusoid spores.

MYCOSPHAERELLA DELPHINIICOLA Earle

Perithecia 150–200 μ in diameter, globose, sparsely or densely scattered, sometimes with a slight amount of radiating subepidermal, brown hyphae. Asci clavate, with a somewhat thickened apical wall, 43–60 × 9–16 μ. Spores biseriate, fusoid-ellipsoid, two-celled, hyaline, constricted at the septum, 12.5–18 × 3.5–5 (6) μ.

On *Delphinium Brownii* Rydb., Camp Davis, June 24 (1045a) and South of Teton Pass, July 11 (1129); and on some composite, Glory Mt., June 20 (1024a).

These collections on *Delphinium* are very similar to those of *M. coerulea*, but slightly larger throughout, with more dark creeping hyphae. *M. delphiniicola* is given with smaller spores (12 × 3 μ), but is used provisionally as the spores may have been immature.

In No. 1045a, a Scolecotrichum-like conidial stage was seen, consisting of upright, somewhat geniculate, septate, brown conidiophores, 50–125 × 3.5–5 μ, which arose from the upper walls of the perithecia or from sterile primordia as in *M. Tassiana*. No conidia were seen attached, but several minute sterigmata could be seen on the light colored tips of the conidiophores and deciduous conidia on the host surface were oblong-cylindric, brown, usually two-celled but becoming four-celled, and (12.5) 16–20 × 7–9 μ. The walls of these conidia were smooth at first, but became finely echinulate at maturity.

Mycosphaerella dolichospora (Sacc. & Fautr.) comb. nov. (FIGS. 11–12)

Sphaerella dolichospora Saccardo & Fautrey, Rev. Myc. 1897, p. 143.

Perithecia thickly scattered or densely clustered, usually on somewhat elongate or widespread areas which are blackened by a growth of stout dark brown, branched hyphae, globose to somewhat conic with a stout ostiole, 100–200 μ in diameter, rather prominently erumpent, with thick (18–36 μ) walls of coarse black parenchyma. Asci stout clavate, with a thickened apical wall, 50–70 × 10–16 μ. Spores fasciculate in the ascus, fusoid-cylindric, straight or slightly curved, two-celled, hyaline, slightly constricted at the septum, (22) 25–40 × 2.5–3.5 μ.

Glory Mt.: June 20, on Umbellifer stems (1026c).

South of Teton Pass: July 11, on *Clematis Douglasii* Hook. (1124 & 1131) and *Carum Carui* L. (1112b).

Skyline Trail: July 24, on *Carum Carui* L. (1166).

These collections are all similar in the long, narrow, fusoid, curved spores and the blackening of the host surface. There are a number of species of *Mycosphaerella* described with such spores, but they are mostly found on the leaves of woody plants. *Sphaerella dolichospora* Sacc. & Fautr. has its spores given as 30–32 × 4 μ and seems to be most like these collections, all of which were made at high altitudes and on two distinct groups of host plants. The spores on *Clematis* (25–35 μ) run somewhat shorter than those on the Umbelliferae.

On both Nos. 1166 and 1026c, the perithecia of this species were associated with small conic to pyriform sclerotia (perithecial

primordia?) up to 100 μ in diameter, which were surmounted by a fascicle of stiff, pointed, brown, septate hairs, up to 150 μ long and 7 μ in diameter (FIG. 12), very similar to the conidial stage described as associated with *M. Tassiana*. Here, however, conidia (FIG. 11) were found scattered or in small clumps, held within this apical fascicle of hairs. These conidia were cylindric-fusoid, hyaline, two-celled, curved, and 35–46 × 3–3.5 μ. Their method of attachment or formation could not be determined. The sclerotia seem to be solid masses of tissue without any cavities. It is possible that these spores are emitted ascospores, but they run somewhat larger in size and are more strongly curved. If borne within the sclerotia, the conidial stage would fall in the form genus *Vermiculariella*.

MYCOSPHAERELLA PEREXIGUA (Karst.) Johans. (FIGS. 7–8)

On *Juncus filiformis* L., Elk Refuge, Jackson, Wyo., July 1 (1072).

This species has asci similar to *M. Tassiana*. They are broadly clavate, usually broader at the base and narrowed toward the apex with a much thickened wall. The perithecia, however, are smaller (40–50 μ) than in *M. Tassiana,* and are evenly scattered in grayish spots or areas. The spores remain fusoid (14–18 × 2.5–3.5 μ) instead of becoming clavate. It is another arctic-alpine species and is similar to *M. Wichuriana* (Schroet.) Johans., on sedges and grasses.

Lind (**8**: 18) says that *M. perexigua* is often associated with *Septoria punctoidea* Karst. Karsten gives the spores of his species as fusoid-bacillar and 12–16 × 1.5–2 μ. Lind (**8**: 36), on the other hand, in his report of this species gives the spores as cylindric, biseptate and 24 × 1 μ. It is such discrepancies which make one suspicious of many reports in the literature. The writer finds on these stems minute pycnidia, 40–50 μ in diameter, which are more widely scattered than the perithecia of *M. perexigua* and which contain fusoid-cylindric, one-celled, hyaline conidia 10–16 × 2–3 μ. Although they would be better placed in *Phoma,* these pycnidia seem to be those of Karsten's *S. punctoidea*.

Again, freely scattered on these stems there are similar patches of small dots, which upon examination prove to be a *Scolecotri-*

chum or *Brachysporium*. The punctate dots consist of small clusters of erect, septate, brown conidiophores arising from a knot of intertwined hyphae or from small sclerotia (perithecial primordia?) (FIG. 7). From the tips of these conidiophores there are cut off singly brown, ellipsoid conidia (FIG. 8) which are one-celled at first but may become 1–4 celled and variable in size with age, from 7–21 × 3.5–6 μ. The walls are very finely roughened in some cases. This same conidial stage is found on *Scirpus* stems (1071) in association with a *Pleospora* and *Metasphaeria juncinella*.

Mycosphaerella Hypodermellae sp. nov. (FIG. 10)

Perithecia globosa, 90–100 μ diametro, pariete crasse parenchymatoso, atro, 25–35 μ crasso, singulatim dispersa vel in lineas ordinata, in folii contextu immersa, ostiolis minutis per rimam communem erumpentibus. Status conidialis in folii superficie per rimas numerosas, 100–300 μ longas, lineares obvius, stromate setiformium conidiophororum 5–6 μ diametro praeditus. Asci fasciculati aggregati, late clavati, primum 70 μ longi, 21 μ crassi, aetate ad longitudinem 85–90 μ, crassitudinem 17–18 μ elongati. Sporae biseriatae, clavatae, ellipsoidales, bicellulae, hyalinae, 13–16 μ longae, 3.5–5 μ latae, apice rotundatae, basi angustatae.

Specimen typicum in foliis viventibus *Pinus Murrayanae* Balf., ad locum dictum "Camp Davis," Jackson, Wyoming, 17 Junii, 1940, legit L. E. Wehmeyer, sub numero 1004b.

Appearing on the surface of the needle as numerous elongate, linear ruptures of the epidermis, 100–300 μ in length, through which a minutely granular stroma or a linear cluster of upright setose hyphae are erumpent. Perithecia globose, 90–100 μ in diameter, with walls of coarse black parenchyma 25–35 μ thick, scattered singly or in linear series, immersed in the leaf tissue and erumpent by means of a minute papillate ostiole through a common rupture, often with a cluster of upright, spine-like conidiophore hyphae, 5–6 μ in diameter. Asci crowded fasciculate, broadly clavate, 70 × 21 μ at first, elongating to 85–90 × 17–18 μ at maturity. Spores biseriate, clavate-ellipsoid, two-celled, hyaline, upper end rounded, tapered toward the base, 13–16 × 3.5–5 μ.

Camp Davis: June 17, on living needles of *Pinus Murrayana* Balf., leg. L. E. Wehmeyer (1004b) (Type).

The pustules of this fungus occur on the older somewhat discolored needles attacked by *Hypodermella concolor*. The dark brown, septate hyphae proliferate in the hysterothecia of this

fungus, or just beneath the epidermis of the leaf and form small stromatic masses from which arise the conidiophores of the *Scolecotrichum* stage. These are upright, brown, closely septate, 5–7 μ in diameter and 85–100 μ long. They bear brown, ellipsoid conidia which soon become two-celled and measure 17–18 × 7 μ. These conidia are deciduous and are seldom seen attached. Both the ascus and conidial stage are similar to *M. Tassiana,* but the asci in this species are more regularly clavate and the perithecia are more globose, and immersed in longitudinal rows. This collection comes closest to *M. Abietis* (Rostr.) Lind but Rostrup gives *Phoma Abietis* and *Toxosporium abietinum* as conidial stages of his species. *M. Peckii* (Sacc.), on hemlock cones, *M. Pinsapo* (Thüm.) and *M. pinicola* Fautr., on needles of fir and pine are also similar but have smaller spores.

NECTRIELLA PEDICULARIS (Tracy & Earle) Seaver

Glory Mt.: On *Umbellifer* stems, June 20 (1026).

South of Teton Pass: July 11, on *Linum Lewisii* Pursh (1134e).

Togwotee Pass: July 8, on *Pedicularis racemosa* Dougl. (1097).

This species is quite common on stems of many hosts at high altitudes. It appears as minute, orange to reddish, rounded, saucer-shaped spots, which are the immersed perithecia. It is commonly found in an immature condition. The perithecia are often scattered and occurred on many more of the collections than those here recorded, which were the only ones examined microscopically.

PHOMATOSPORA THEROPHILA (Desm.) Sacc.

Perithecia 200 μ in diameter, appearing on the stems as black spot-like clusters, barely erumpent. Asci cylindric, 44–55 × 6–7 μ, with numerous paraphyses which are taper-pointed and guttulate. Spores oblique uniseriate, fusoid-ellipsoid, one-celled, hyaline, 7–9 × 2.5–3 μ.

On *Juncus filiformis* L., Elk Refuge, Jackson, Wyo., July 1 (1072a).

These are the largest of the many different pycnidia and perithecia intermingled on these stems.

ROSELLINIA OVALIS (Ell.) Sacc. (FIG. 20)

Perithecia superficial, globose, carbonaceous, 200–300 μ in diameter, with a wall 25–50 μ thick, of fine brownish hyphae, and surrounded by an evanescent weft of brownish hyphae. Asci long cylindric, 90–125 × 7–7.5 μ. Paraphyses broad band-like. Spores uniseriate, oblong-ellipsoid, somewhat flattened, with a longitudinal germ slit along the narrow side, 8.8–10.5 × 6–7 × 5–6 μ.

Camp Davis: July 4, on decorticated wood of *Salix* (1079).

The type, Ellis N.A.F. No. 896, of this species shows the same flattened spores with a germ slit on the narrow side. It differs only in the lack of the basal weft of hyphae, which may disappear.

Sphaerulina Gentianae sp. nov. (FIGS. 17–19)

Perithecia dispersa in foliis et caulibus, 400–500 μ diametro, globosa vel conica, basi applanata, sub epidermate formata, deinde erumpentia, superficialia, aetate irregulariter collapsa; ostiolo parvo, papilliformi; pariete parenchymatoso, intus hyalino, extus atro, crasso, contextu caulis circum peritheciorum bases nigricanti. Asci cylindrici-clavati, 150–160 μ longi, 32–39 μ crassi, pariete incrassato. Paraphyses nulli. Sporae biseriatae vel uniseriatae, imbricatae, ellipsoideae, hyalinae, 46–54 μ longae, 14–18 μ crassae, primum bicellulae, deinde 4-cellulae, ad septum paulum constrictae, granulosae, in parte inferiore quam superiore angustiores, cellulis omnibus uniguttulatis.

Specimen typicum in foliis et caulibus *Gentianae calycosae* Griseb., secus viam "Skyline Trail," Teton National Park, Wyoming, 24 Julii, 1940, legit L. E. Wehmeyer, sub numero 1174.

Perithecia scattered on both leaves and stems, formed just beneath the epidermis, but soon erumpent, superficial, globose to conic, with a flattened base, 400–500 μ in diameter, causing a blackening of the tissue about the base, ostiole small papillate, wall thick (60–70 μ), with an outer layer (20–30 μ) of coarse black parenchyma and an inner hyaline layer which is much thickened below. Perithecia collapsing in an irregular wrinkled manner with age. Asci cylindric-clavate, 150–260 × 32–39 μ, with a thickened apical wall. No paraphyses present. Spores biseriate to overlapping uniseriate, ellipsoid, hyaline, contained in an evanescent gelatinous envelope, two-celled at first, becoming four-celled at maturity, slightly constricted at the septa, contents granular with a large angular fat (?) body in each cell, 46–54 × 14–18 μ. The lower half of the spore is often somewhat narrower than the upper.

Skyline Trail: On *Gentiana calycosa* Griseb., July 24, behind Grand Teton Peak (1174) (Type); and Aug. 5, at Overlook (1210).

Both these collections were found above 9000 feet elevation, on the same host and occur on both stems and leaves, indicating that it may be parasitic and so limited in its host range.

In the immature two-celled condition of the spores, it might easily be mistaken for a *Didymella* or *Massarinula*. In the four-celled condition, with the gelatinous envelope, the spores look very much like those of a *Massarina*. *Metasphaeria* and *Sphaerulina* are also possibilities. The lack of paraphyses and the erumpent-superficial habit on both stems and leaves seem to place it in the latter genus. There seems to be no such fungus described in any of these genera.

Sphaerulina inaequalis sp. nov. (FIG. 15)

Perithecia dense dispersa, immersa deinde erumpentia, depresse globosa, 180–250 μ diametro; ostiolo centrali, papilliformi; pariete parenchymatoso, crasso, atro. Asci clavati, 50–75 μ longi, 14–15 μ crassi; ad basin attenuati, quando vacui collapsantes sed persistentes. Paraphyses nulli. Sporae biseriatae, fusiformiter ellipsoidales, inaequilaterales vel paulum curvatae 18–25 μ longae, 3.5–4 μ crassae, tricellulares, interdum ad septa paulum constrictae; cellulis exterioribus quam interiore brevioribus.

Specimen typicum in caulibus vetustis *Hedysari uintahensis* A. Nels., prope Teton Pass, Jackson, Wyoming, 11 Julii, 1940, legit L. E. Wehmeyer, sub numero 1126e.

Perithecia rather thickly scattered, immersed beneath the epidermis, then erumpent, flattened spheric, with a central papillate ostiole, 180–250 μ in diameter, with a wall 20–30 μ thick and composed of coarse black parenchyma. Asci clavate, with a tapered base, 50–75 × 14–15 μ, wall collapsing when empty but persistent. No paraphyses present. Spores biseriate, fusoid-ellipsoid, inequilateral to slightly curved, three-celled, with the two septa cutting off two short end cells and one longer central cell, sometimes slightly constricted at the septa, 18–25 × 3.5–4 μ.

South of Teton Pass: July 11, on *Hedysarum uintahense* A. Nels., leg. L. E. Wehmeyer (1126e: type).

This species is characterized by the biseptate, unequally three-celled spores. The asci collapse when empty, but persist as a wrinkled membrane. The absence of paraphyses places this spe-

cies in *Sphaerulina* rather than *Metasphaeria*. Intermingled with the perithecia, there were found pycnidia of an *Apiocarpella* (sp.).

STRICKERIA OBDUCENS (Fr.) Wint.

Perithecia thickly scattered, superficial on the blackened wood surface, globose, 400–500 μ in diameter, with a minute papillate ostiole, wall 40–100 μ thick, of small flattened pseudoparenchyma. Asci long cylindric, 130–140 × 15–16 μ. Paraphyses present only as interthecial strips which disappear at maturity. Spores oblique uniseriate, fusoid-ellipsoid, brown, 5–7 septate, constricted at the central septum, with one vertical septum in several, but usually not all, of the middle cells, 23–30 (32) × 9–10.5 μ.

Camp Davis: June 18, on decorticated *Commandra pallida* DC. stems (1011a).

This collection is more or less intermediate in its measurements between *S. obducens* and *Teichospora megastega* E. & E.

SPORORMIA AUSTRALIS Speg.

Hoback Forest Camp: on horse dung, July 22 (1232).

There are a number of species of *Sporormia* described with 4-celled ascospores similar to those of this collection. The papilliform ostioles and the measurements of the spores (35–40 × 6–7.5 μ) and asci (90–130 × 10–17 μ) of this species, however, make it most similar to Cain's (**1**) description of *S. australis*.

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LITERATURE CITED

1. **Cain, R. F.** Studies of coprophilous Sphaeriales in Ontario. Univ. of Toronto Stud., Biol. Ser., No. **38**. 126 pp. 1934.
2. **Darker, G. D.** The Hypodermataceae of conifers. Contr. Arnold Arb. **1**: 1–131. 1932.
3. **Dearness, J.** New or noteworthy North American fungi. Mycologia **9**: 345–364. 1917.
4. **Höhnel, F. von.** Fragmente zur Mykologie. VIII Mitt., Nr. **354–406.** Sitz. Akad. Wiss. in Wien, math-naturw. Kl. **118**: 1157–1246. 1909.
5. ——. Mykologische Fragmente. Ann. Myc. **16**: 35–174. 1918.
6. **Lagerberg, T.** Om gråbarrsjukan hos tallen dess orsak och verkningar. Skogsv. Tidskr. Fack. (Meddel. Från Statens Skogsv.) **8**: 221–242, 357–382. 1910.

7. **Lind, J.** Micromycetes from north-western Greenland found on plants collected during the Jubilee Expedition, 1920–23. Meddel. om Groenl. **69**: 161–179. 1926.
8. ——. The Micromycetes of Svalbard. Skrift. om Svalbard, Nr. **13**. Kon. Dept. f. Handel etc. 61 pp. Oslo. 1928.
9. **Miller, J. H. & Thompson, G. E.** Georgia Pyrenomycetes I. Mycologia **32**: 1–15. 1940.
10. **Rehm, H.** Ascomycetes novi. IV. Ann. Myc. **9**: 363–371. 1911.
11. **Solheim, W. G.** Mycoflora Saximontanensis Exsiccata. Univ. Wyo. Publ. in Sci., Botany. I—**1**: 219–232. 1934. II—**3**: 89–99. 1937. III—**7**: 29–42. 1940. IV—**10**: 33–46. 1943.
12. **Sydow, H. & P.** Mykologische Mitteilungen. Ann. Myc. **17**: 33–47. 1919.
13. **Theissen, F.** Über *Tympanopsis* und einige andere Gattungenstypen. Ann. Myc. **15**: 269–277. 1917.
14. **Wier, J. R.** A new leaf and twig disease of *Picea Engelmanni*. Journ. Agr. Res. **4**: 251–253. 1915.
15. **Winter, G.** Die Pilze Deutschlands, Oesterreichs und der Schweiz. Ascomyceten: Gymnoasceen und Pyrenomyceten., in Rabenhorst, Krypt.-Flora, vol. **1**, abt. 2. Leipzig. 1887.

DESCRIPTION OF FIGURES

(All spores are drawn to a scale of approximately 1 mm. equals 1 μ)

FIG. 1. Vertical section of perithecium of *Apiosporella Mimuli* sp. nov.

FIG. 2. Ascospores of *Apiosporella alpina* sp. nov.

FIG. 3. Ascospores of *Apiosporella Mimuli* sp. nov.

FIG. 4. Ascospores of *Didymella Castillejae* sp. nov.

FIG. 5. Typical ascus and ascospores of *Mycosphaerella Tassiana* (de Not.) Johans. from collection on *Castilleja* (1159c) showing smaller size range.

FIG. 6. Typical ascus and ascospores of *Mycosphaerella Tassiana* (de Not.) Johans. from collection on *Agastache* (1109) showing larger size range.

FIG. 7. Scolecotrichum-type of conidial stage found associated with *Mycosphaerella perexigua* (Karst.) Johans.

FIG. 8. Conidia of *Scolecotrichum* stage associated with *Mycosphaerella perexigua* (Karst.) Johans.

FIG. 9. Type of conidial stage found associated with *Mycosphaerella Tassiana* (de Not.) Johans., showing conidiophores borne on sclerotia (left) and in fascicles (right) and two-celled conidia.

FIG. 10. Section through needle of Pine infected with *Mycosphaerella Hypodermellae* sp. nov. *a*, perithecia in old hysterothecial cavities of *Hypodermella concolor* (Dearn.) Darker. *b*, empty infected *Hypodermella* cavities. *c*, Conidiophores and conidia formed from mycelia proliferating on such cavities.

FIG. 11. Conidia found associated with *Mycosphaerella dolichospora* (Sacc. & Fautr.) comb. nov.

FIG. 12. Setose sclerotia, bearing conidia, among the setae, and found associated with *Mycosphaerella dolichospora* (Sacc. & Fautr.) comb. nov.

FIG. 13. Vertical section of perithecium of *Guignardia Epilobii* (Wallr.) comb. nov.

FIG. 14. Ascospores of *Guignardia Epilobii* (Wallr.) comb. nov.

FIG. 15. Ascospores of *Sphaerulina inaequalis* sp. nov.

FIG. 16. Ascospores of *Metasphaeria juncinella* Mout.

FIG. 17. Vertical section of perithecium of *Sphaerulina Gentianae* sp. nov.

FIG. 18. Ascus and ascospores of *Sphaerulina Gentianae* sp. nov.

FIG. 19. Ascospores of *Sphaerulina Gentianae,* with gelatinous envelope which is present when first released from the ascus.

FIG. 20. Ascospores of *Rosellinia ovalis* (Ell.) Sacc., showing germ slits.

STUDIES IN THE GASTEROMYCETES XIII THE TYPES OF MISS WHITE'S SPECIES OF TYLOSTOMA

W. H. LONG

(WITH 4 FIGURES)

When I began an intensive study of the genus *Tylostoma* a special effort was made to locate the types of the species published by Miss White (**1901**), since it was found necessary to examine them in order to be certain just what species she really had. This was especially desirable as much of my *Tylostoma* material came from the southwestern states and several of her species were based on specimens from this region.

I wrote to those herbaria which might have her types but was unable to locate them with the possible exception of material deposited in the New York Botanical Garden, which was the logical place for them to be. Dr. Seaver very kindly made several extended searches through the *Tylostoma* material there, but was unable to find anything specifically marked as Miss White's types. However, by a process of reasoning he was able to locate all her types inferentially. By locating specimens that corresponded to her data on collector, where collected, and her description of each species, he found what is undoubtedly the type material used by her in writing her article although there was nothing on the individual specimens to show that she had ever touched them. Apparently she wrote her descriptions for each of her new species, leaving the changing of the labels on the collections to a later date, which never came. As an illustration, *Tylostoma albicans* is recorded by her from Texas, Collector E. D. Cope. A collection by Cope from Texas was found and was the only material that she could have used. Since her description of *T. albicans* corresponds to this particular collection it is considered the type material. This process was repeated for her other species, and I am sure that the collections listed below are parts, if not all, of her type material for each. In the redescriptions which follow, the original legend

found with each collection is given, also the number and condition of the plants in it, and a redescription of the species is made from these type specimens.

TYLOSTOMA ALBICANS WHITE: TYPE FROM THE NEW YORK BOTANICAL GARDEN

Original legend: "*T. mammosum* Quélet, Texas, 1893, E. D. Cope." This collection consists of three loose sporocarps and six pieces of stems, two of these pieces have bases. *Sporophore* consisting of sporocarp, stipe and slightly bulbous base. *Sporocarp* depressed-globose, 5–7 mm. tall by 10–13 mm. wide; apparently rather loosely attached to stem apex. *Exoperidium* a sand case, completely deciduous on two plants and mostly so on the third. *Peridial sheath* a narrow band of hyphae and sand beneath sporocarp, 2–4 mm. wide, mainly persistent. *Endoperidium* thin, membranous, pinkish buff to cartridge buff to dingy white. *Mouth* small, tubular, tube very short, circular to oval, 1–2 mm. across. *Collar* inconspicuous, 2–3 mm. distant from stem. *Stipe* broken up and length not ascertainable, even, 3–5 mm. thick, brittle, with small, cartridge buff to dingy white, lacerate, appressed scales; two have disjointed sporocarps. *Bulb* 3–5 mm. thick with a trace of volva having pieces of stem cortex inside on one stem. *Radicating base:* none. *Gleba:* cinnamon. *Capillitium* hyaline, branched, lumen small, 4–7 μ thick, septa not seen. *Spores* subglobose, 5–6 μ, some apiculate. *Epispore* smooth to verruculose.

TYPE LOCALITY: Texas.

HABITAT: apparently in unshaded areas and not in leaf debris as there was no debris left on bases of stems.

TYLOSTOMA POCULATUM WHITE: FROM LLOYD NO. 33642, PART OF TYPE

Original legend: "*Tylostoma poculatum* White, Long Pine, Nebraska, Feb. 3, 1896, *J. M. Bates,* Type specimens." This collection consists of three loose sporocarps, two with pieces of attached stems but bases gone, and six fragments of stems, two of these fragments being detached bases. *Sporophore* consisting of sporocarp, stipe and slightly bulbous base. *Sporocarp* subglobose,

4–6 mm. high by 8–10 mm. in diameter, firmly attached to stem apex but easily breaking off in or near the socket but not disjointed. *Exoperidium* strongly and permanently membranous, drying into a thin fragile envelope, soon deciduous in flakes and often leaving lacerate shreds of dried membrane around top of peridial sheath. *Peridial sheath* a thick band of agglutinated hyphae and sand, 4–6 mm. broad, often with a somewhat cup-shaped flaring upper margin. *Endoperidium* perfectly smooth, tilleul-buff, membranous. *Mouth* with a fibrillose mat peristome, small fibrils slowly wearing away. *Collar* inconspicuous, close to stem. *Stipe* short, 1.5–2 cm. tall by 3 mm. thick, even, wood brown, walls very thin and fragile, easily breaking—especially near the sporocarp. *Volva* and *radicating base* none; *base* slightly bulbous. *Gleba* light buff. *Capillitium* hyaline, sparingly branched, septa rare, swollen, 4.2–7 μ thick, lumen small to none. *Spores* 4.2–5.6 μ, subglobose, tinted. *Epispore* smooth, tinted, wall 1 μ thick.

TYPE LOCALITY: Long Pine, Nebraska. (Not "Lone" Pine as published.)

TYLOSTOMA MINUTUM WHITE: TYPE FROM NEW YORK BOTANICAL GARDEN

Original legend: "*Tylostoma obesum* C. & E. Dwarf variety, Colorado, Bethel No. 22a." This collection consists of three plants, two with pieces of stems attached and a loose sporocarp with a very short stem. *Sporophore* consisting of sporocarp and stipe, no bases present. *Sporocarp* subglobose, 6–10 mm. tall by 8–12 mm. wide, firmly attached to stem apex but easily breaking off near socket. *Exoperidium* plainly membranous, early and completely deciduous on these three plants. *Peridial sheath* persistent, a thick band of hyphae and sand, 3–5 mm. wide. *Endoperidium* perfectly smooth, thin, membranous, two of sporocarps fawn color the remaining head a lighter color (vinaceous buff). *Mouth* fibrillose, raised, seated in a slight depression, circular, not open on the two large plants, but a slight pin hole present in the peristome of the smaller light-colored plant, fibrillose; peristome 3 mm. across, slightly darker than the endoperidium on the two large plants but concolorous with the endoperidium on the smaller

plant. *Collar* inconspicuous, close to stem, 1–2 mm. distant. *Stipe* (the fragments about 1 cm. long) even, terete, walls thin and weak, easily breaking, light brown (wood brown) or a slightly lighter color on one, slightly striate next to head on one. *Gleba* cinnamon rufous. *Capillitium* hyaline, sparingly branched, septa rare, slightly swollen 4–7 μ thick, lumen small. *Spores* subglobose, 4–5.6 μ, 1-guttulate, a few apiculate, tinted. *Epispore* mostly smooth, a few verruculose.

TYPE LOCALITY: Colorado. This species is based on young freshly emerged plants as evidenced by the unopened mouths and the darker endoperidia, characters common to *T. poculatum* in same stage of growth. According to Long (**1946**), *T. minutum* is a synonym of *T. poculatum*, both having all their major characters identical.

TYLOSTOMA TUBERCULATUM WHITE: TYPE FROM NEW YORK BOTANICAL GARDEN

Original legend: "*Tylostoma obesum* C. & E. British Columbia, Macoun." This collection consists of eleven sporocarps, four of them with short pieces of stems attached. *Sporophore* consisting of sporocarp and stems. *Sporocarp* subglobose to depressed-globose, 8–12 mm. tall by 10–15 mm. wide, easily separating from apex of stem usually by breaking at juncture of stem and apex. *Exoperidium* a granular sand coat, completely deciduous on all 11 heads. *Peridial sheath* prominent, permanent, a heavy band of hyphae and sand under head, 4–5 mm. wide. *Endoperidium* light buff, smooth, tough, membranous. *Mouth* fibrillose, circular, raised, becoming somewhat enlarged and lacerate with age, but fibrillose mat still persisting around the enlarged orifice, peristome about 3 mm. in diameter, concolorous with the endoperidium. *Collar* inconspicuous, 1–2 mm. distant from stem. *Stipe* weak, easily breaking, apparently even, striate or slightly so, cinnamon color. Base of *stems* gone. *Gleba* hazel. *Capillitium* hyaline, 5–7 μ thick, much branched, septa rare and not swollen, lumen small. *Spores* subglobose, often irregular, 4.5–6 μ. *Epispore* smooth.

TYPE LOCALITY: British Columbia.

TYLOSTOMA SUBFUSCUM WHITE: TYPE FROM THE NEW YORK BOTANICAL GARDEN

Original legend: "*Tylostoma campestre* Morgan, Denver, Colorado, Feb. 16, 1896, Bethel No. 21." This collection consists of two plants, both with bases of stems broken off and gone. *Sporophore* consisting of sporocarp and stipe, originating 2 cm. below the surface of soil. *Sporocarp* subglobose, 10–12 mm. tall by 11–14 mm. wide, firmly attached to stem apex. *Exoperidium* a granular sand coat, completely deciduous on the two heads. *Peridial sheath* prominent, 3–5 mm. wide, persistent, a band of hyphae and dirt (not sand) beneath head. *Endoperidium* smooth, tough, dusky (light cinnamon drab to cinnamon drab), membranous, wrinkled. *Mouth* circular, prominent, raised, fibrillose, rather large, peristome 5 mm. across, mouth parts firm and not breaking up, mouths in these two plants not open, concolorous with endoperidium. *Collar* inconspicuous, close to stem, ½ to 1 mm. distant. *Stipe* even, terete, walls thin, lumen large, not very stout, slightly sulcate, pecan brown on one, the other covered with dirt, no signs of scales on either stem, base of stems on both plants broken off hence *bulb,* if any, gone. *Gleba* cinnamon. *Capillitium* hyaline, 5–6 μ thick, septa rare, slightly swollen, lumen small, sparingly branched. *Spores* subglobose, 4–5 μ, some apiculate. *Epispore* minutely verruculose.

TYPE LOCALITY: Denver, Colorado.

HABITAT: in clay soil judging by the dirt on stem.

TYLOSTOMA FIBRILLOSUM WHITE: TYPE FROM NEW YORK BOTANICAL GARDEN

Original legend: "*Tylostoma punctatum* Peck, sand dunes east shore of Lake Huron, Canada, September 1891, J. Dearness." This collection consists of one plant with sporocarp loose and stem broken in half. *Sporophore* consisting of sporocarp, stipe, and bulbous base, originating 3 cm. below surface of soil. *Sporocarp* subglobose, 12 mm. tall by 16 mm. wide. *Exoperidium* a granular sand coat, completely deciduous on this plant. *Peridial sheath* 5 mm. broad, prominent, persistent, a heavy band of hyphae and sand beneath head. *Endoperidium* white, smooth, tough, mem-

branous. *Mouth* a fibrillose thin mat, tough, parts not weak, slightly raised, elliptical, 3 mm. wide by 4 mm. long including peristome. *Collar* inconspicuous, about 1 mm. distant from stipe. *Stipe* stout, very slightly tapering to base, 6 cm. tall by 6 mm. thick at top and 5½ mm. at base, thick at base, walls thick, woody, about 2 mm., lumen small, curved in this specimen, terete, not fragile, expanding abruptly at base into a thin woody bulb which was enclosed with sand before too much handling, sulcate above, lower half was apparently covered with a layer of sand and hyphae, with a few strands of the mycelium still persisting, base of stipe white, flattened, with sand attached to bottom of the white disc, color of stipe pecan brown (not white as stated by author), with small appressed scales. *Bulb* persistent with a white flattish central core, still present, the core 6 mm. across. *Gleba* cinnamon rufous to ferruginous. *Capillitium* hyaline, lumen medium, ends rounded, septa rare, not swollen 5–7 μ thick. *Spores* subglobose, 5–6 μ. *Epispore* distinctly verruculose.

TYPE LOCALITY: East shore of Lake Huron, Canada.

HABITAT: on sand dunes along shores of lake.

TYLOSTOMA KANSENSE PECK IN WHITE: FROM NEW YORK BOTANICAL GARDEN

Original legend: "Kansas Fungi, collected by Elam Bartholomew, July 24, 1896, in hard bare soil, Rooks Co., Kansas, type material." This collection consists of a flattened sporocarp, remainder of plant destroyed by insects. I therefore had to supplement my description with data from other, but authentic material. Original legend on this supplementary material: "Kansas Fungi, collected by Elam Bartholomew, *Tylostoma kansense vide* Peck, in open cultivated soil, Rooks Co., Rockport, October 28, 1901," Lloyd No. 24729. This collection consists of six plants with sporocarps attached to stems, but with only two perfect stems with bases, also three pieces of stems, one piece with a base. *Sporophore* consisting of sporocarp, stipe and volva. *Sporocarp* subglobose, 1–1.5 cm. high by 1–1.5 cm. wide, firmly attached to stem apex, somewhat flattened beneath. *Exoperidium* a sand case, slowly deciduous. *Peridial sheath* a narrow band of agglu-

tinated hyphae and dirt, persistent, 2–5 mm. wide beneath sporocarp. *Endoperidium* tough, membranous, white, with small particles of dirt here and there on surface. *Mouth* indefinite, an irregular lacerate orifice in these plants, naked, plane. *Collar* varied, short on some, 1–2 mm. distant from stem on others, pendant around stem for 2 mm., 1 mm. distant from stem, continuous with peridial sheath. *Stipe* stout, 1–5 cm. tall by 5–8 mm. thick, rugose, even, white, often longitudinally striate. *Volva* inconspicuous with pieces of stem cortex inside. *Base of stipe* slightly bulbous 4–5 cm. thick, sometimes radicating. *Gleba* cinnamon rufous. *Capillitium* hyaline to tinted, walls moderately thick, about 1 μ, flexuous, uneven in thickness, ends rounded, short knob-like branches here and there, 4–5 μ thick, septa not seen, sparsely branched, constricted in places. *Spores* subglobose, subhyaline, 4.2–5 μ in dia., some $4 \times 5\ \mu$, uniguttulate, irregular in shape. *Epispore* about 1 μ thick, subhyaline, smooth.

TYPE LOCALITY: Rockport, Kansas.

HABITAT: in open hardpan soil.

TYLOSTOMA GRACILE WHITE: TYPE FROM NEW YORK BOTANICAL GARDEN

Legends: See figures 2, 3 and 4, which are self explanatory. This collection consists of only one plant (FIG. 1) with mouth much lacerated. *Sporophore* consisting of sporocarp, stipe and very slightly enlarged base. *Sporocarp* depressed-globose, 1.2 cm. tall by 2 cm. wide. *Exoperidium:* none present. *Peridial sheath:* none present. *Endoperidium* thin, membranous, smooth, rather shining, cinnamon color. *Mouth* indefinite, plane, lacerate. *Collar:* none. *Stem* slender, 5.5 cm. long by 7 mm. thick at top and 4 mm. at bottom which is slightly enlarged, somewhat sulcate, slightly lacerate, darker than endoperidium. (This specimen has never been cut into hence the statement "white within and without, fibrillose-stuffed, becoming hollow," is a pure guess.) *Gleba* ferruginous. *Capillitium* hyaline to slightly tinted, threads not as well defined as in *Tylostoma,* flaccid, 3.5–5.6 μ thick, *septa* not seen. *Spores* globose, uniguttulate, 5.6–7.5 μ in diameter. *Epispore* fulvous, moderately but distinctly echinulate.

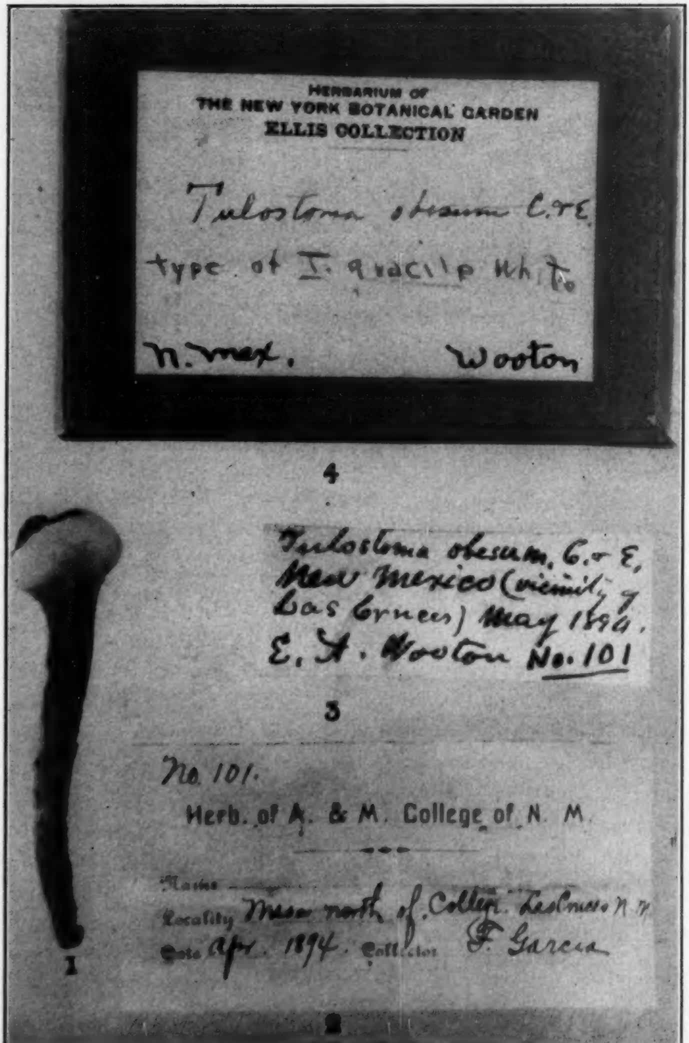

FIG. 1. Type of *Tylostoma gracile*
FIGS. 2–4. Labels on box and with type of *T. gracile*

Miss White's figure of this species was undoubtedly made from the above described plant even to the slight remnant of the inner layer of the volva-cup shown at the base of her figure and the curves in the stem (FIG. 1). This plant used as the type of "*Tylostoma gracile*" is a small typical *Chlamydopus meyenianus* without its volva.

The first legend, figure 2, gives the original data on the collection but no name for the fungus; figure 3 is Wooton's label and shows the same plant as figure 2 but was given a name by Wooton when he sent it in May to the New York Botanical Garden; figure 4 shows the present label on the box top containing the specimen. the other 2 labels are inside the box. "Type of *T. gracile*" was inserted recently by the Garden authorities, not by Miss White.

No wonder Lloyd (**1906**) was unable to recognize "*Tylostoma gracile*," he evidently took at face value the type description and looked for it under the genus *Tylostoma*.

ACKNOWLEDGMENTS

I wish to make grateful acknowledgments to Dr. Fred J. Seaver for helpful suggestions and for the loan of valuable material and to John A. Stevenson for loan of material.

ALBUQUERQUE,
NEW MEXICO

LITERATURE CITED

Lloyd, C. G. 1906. Myc. Writ. **2**: The Tylostomeae, 27 pp.

Long, W. H. 1946. Studies in the Gasteromycetes XII. Five species of *Tylostoma* with membranous exoperidia. Mycologia **38**: 77–90.

Ridgway, Robert. 1912. Color standards and color nomenclature. Washington, D. C.

White, V. S. 1901. The Tylostomaceae of North America. Bull. Torrey Club **28**: 421–444.

CONTRIBUTIONS TO THE MYCOFLORA OF BERMUDA—IV

F. J. Seaver and J. M. Waterston

(with 8 figures)

The present paper is the fourth of a series (Seaver & Waterston **1940**, **1941**, **1942**) based on determinations of fungi which have been collected in the Bermuda Islands during the last three decades. During the autumn of 1944, the junior author was granted leave of absence from Bermuda to work over material collected by the senior author together with H. H. Whetzel and Lawrence Ogilvie during January—February 1926, with a view to preparing a complete list of the local fungi. Much of this material had remained for many years unstudied at Cornell University.

The total number of named species of Schizomycetes, Myxomycetes, Phycomycetes, Ascomycetes, Ascolichenes, Basidiomycetes and Fungi Imperfecti recorded to date from Bermuda now amounts to over 750. These are distributed among 310 genera. Nearly 68.4 per cent of the total number of recorded species are contained in the following seven orders: Moniliales, 109; Agaricales, 84; Phyllostictales, 74; Sphaeriales, 68; Uredinales, 60; Lecanorales, 58 and Melanconiales, 30.

The general aspect of the mycoflora is sub-tropical or temperate North American, as one might expect in view of the Islands' geographical position. There is a noteworthy absence of orders which commonly predominate in strictly tropical regions and members of the Dothideales and Hemisphaeriales are poorly represented. The number of endemic species is small and is less than 7 per cent of the total number recorded.

About 64 per cent of the species are saprophytic and few are strictly terrestrial. Most of the saprophytic species occur on the debris of higher plants. The total number of species of fungi found associated with either living or dead parts of some of the commonest flowering plants is as follows: *Sabal bermudana*, 60; *Juniperus bermudiana*, 55; *Citharexylum spinosum*, 26; *Nerium*

Oleander, 20; *Musa Cavendishii*, 15; *Melia Azedarach*, and *Myrica cerifera*, 14; *Agave* sp., *Elaeodendron Laneanum*, *Lycopersicon esculentum* and *Solanum tuberosum*, 12; *Coccolobis uvifera* and *Jasminum gracile*, 11; and *Rhizophora Mangle*, 10.

Although the total number of fungi recorded from Bermuda is quite satisfactory in view of the small area of the Islands, some 19 square miles, nevertheless the writers feel that a considerable amount of collecting work still remains to be done, particularly with regard to the soil inhabiting and aquatic species.

PHYCOMYCETES

DELACROIXIA CORONATA (Cost.) Sacc. & Sydow

This species was obtained in culture during an attempt to obtain spore shootings from apothecia of *Pseudopithyella minuscula* (Boud. & Torrend) Seaver, growing on decayed twigs of *Juniperus bermudiana* L., Agricultural Station, Paget East, Jan. 27, 1943, J. M. Waterston, det. D. H. Linder. It is of interest to note that White (**1937**: 148) has also reported this fungus on an operculate discomycete, *Peziza domiciliana* Cooke, at Ithaca, N. Y., as well as on other substrates.

The entomogenous nature of this species demonstrated by Kevorkian (**1937**: 194) was confirmed when dry-wood termites, *Kalotermes approximatus*, taken from Bermuda cedar, *Juniperus bermudiana* L., were exposed for two hours to petri dish cultures on 2 per cent dextrose potato agar and subsequently transferred to a moist chamber. Death took place in all specimens exposed to this treatment within eight hours. The fungus was only effective under conditions of high humidity and has not been found on dry-wood termites in the field in Bermuda. Martin (**1942**: 145) gives notes on the facultative parasitism of this species on insects and also deals with its synonymy.

ENTOMOPHTHORA VIRESCENS Thaxter

Parasitic on larvae of *Feltia subterranea* F., without definite station, December 1927, *L. Ogilvie 34937 (CU)*. This is the species reported by Ogilvie (**1928**: 35) as being common on the dead bodies of cutworms found adhering to the leaves of plants

during the winter months. The discharged conidia form a flowing margin around the larvae, greenish-yellow in color in dried material. The ovate conidia measure $35 \times 14\ \mu$. Previously known from Ontario, Canada, and Wooton, England.

PILOBOLUS KLEINII van Tiegh.

Discharged sporangia of this species caused disfigurement of the foliage of cauliflowers and cucumbers growing in a greenhouse, Paget East, Feb. 15, 1939, *H. S. Cunningham 34843, 34844* (*CU*). The same species was found under similar circumstances on leaves of *Chrysanthemum morifolium* Ram., in a greenhouse in Watervliet, New York, Oct. 22, 1932, *J. L. Young 20890* (*CU*).

ASCOMYCETES

Bulgaria Thwaitesii (Berk. & Br.) comb. nov. (FIG. 1)

Rhizina Thwaitesii Berk. & Br. Jour. Linn. Soc. (Bot.) **14**: 102. 1875.

Sarcosoma Thwaitesii (Berk. & Br.) Petch, Annal. Roy. Bot. Gard. Peradeniya **4**: 420. 1910.

This is not a Bermuda species but it has been reported in association with witches' brooms on Bermuda cedar, *Juniperus bermudiana* L., in Ceylon by Petch (**1910**: 421) and Boedijn (**1932**: 277) has suggested that it is this species that occurs on the same host in Bermuda. However one of us (Seaver **1928**: 198, **1942**: 320) has shown that the Bermuda species is referable to *Bulgaria melastoma* (Sow.) Seaver. Figure 1 (upper) shows this species on rotten bark of *Juniperus bermudiana* L., from roots of living trees exposed at soil level, Walsingham, Bermuda, Jan. 20, 1922, *H. H. Whetzel Bermuda Fungi No. 188*. This plant is characterized by apothecia which are frequently stipitate, with almost smooth, hyaline, ellipsoidal spores, $20\text{–}25 \times 9\text{–}10\ \mu$.

In contrast, the Ceylon fungus, for which the new combination given above is proposed, is typically sessile, and has far larger spores, $34\text{–}44 \times 15\text{–}20\ \mu$. These are covered with flattened warts. Figure 1 (lower) shows material of *Sarcosoma Thwaitesii* (Berk. & Br.) Petch, from branches of *Juniperus bermudiana* L., Peradeniya, Ceylon, Sept. 13, 1913, *T. Petch, Sydow Fungi*

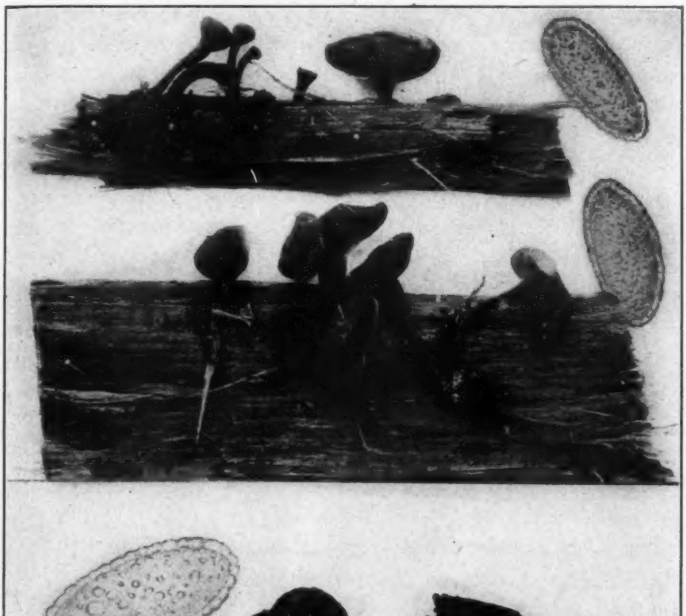

FIG. 1. (upper) *Bulgaria melastoma* from Bermuda × 1; (lower) *Bulgaria Thwaitesii* from Ceylon × 2. Both specimens fruiting on *Juniperus bermudiana*. Both spores × 1000.

exotici No. 424. This species does not appear to have been recorded in America. On the other hand, *B. melastoma* has a wide range in America. One interesting record of the latter, is a collection on *Juniperus barbadensis* L. (= *J. virginiana* L.), from Cinchona, Jamaica, B. W. I., Dec. 25–Jan. 8, 1908–09, *W. A. Murrill & Edna L. Murrill 652* (*NY*). The material was taken in a wet mountainous region at 4,500–5,200 feet elevation. The ascospores averaged 30 μ in length and were longer and more slender than the Bermuda material on *J. bermudiana*.

Catabotrys deciduum (Berk. & Br.) comb. nov. (FIG. 2)

Hypoxylon deciduum Berk. & Br. Jour. Linn. Soc. **14**: 120. 1875.

Bagnisiella palmarum Pat. Bull. Soc. Myc. France **3**: 176, 177. 1887.

Catabotrys palmarum (Pat.) Theiss. & Sydow, Ann. Myc. **13**: 297, 298. 1915.

On fallen leaf bases of tall bananas, *Musa* sp., Devonshire, Feb. 3, 1926, *F. J. Seaver, H. H. Whetzel & L. Ogilvie 34897* (*CU*); on dead petioles of *Sabal bermudana* Bailey, on the ground, Walsingham, Jan. 20, 1922, *H. H. Whetzel 35004* (*CU*).

Previously known only from Central Provinces, India; Ceylon; Bintula, Borneo and New Caledonia. The Bermuda record is a noteworthy extension of range of this beautiful and interesting species. The writers are indebted to Dr. Julian H. Miller who examined the material on *Musa* and pronounced it identical with the type of *Hypoxylon deciduum* Berk. & Br., at Kew Herbarium.

The fungus is characterized by pulvinate stromata which rest on a subiculum and are entirely superficial (FIG. 2a). The perithecia have very long ostioles and are deeply imbedded in stromatic columns which become separated with age but remain united above. The spores are hyaline, ellipsoid and average 6–7 × 3 μ (FIG. 2b). Paraphyses are absent. Petch (**1924**: 163) lists this fungus in his Xylariaceae Zeylanicae among species *Dubiae et excludendae*, and gives the spore range for Ceylon material (No. *2881*) 6–9 × 3 μ. He notes that Cooke (**1883**: 123) gave the spore range 15–18 × 3 μ and had passed it as *Hypoxylon*.

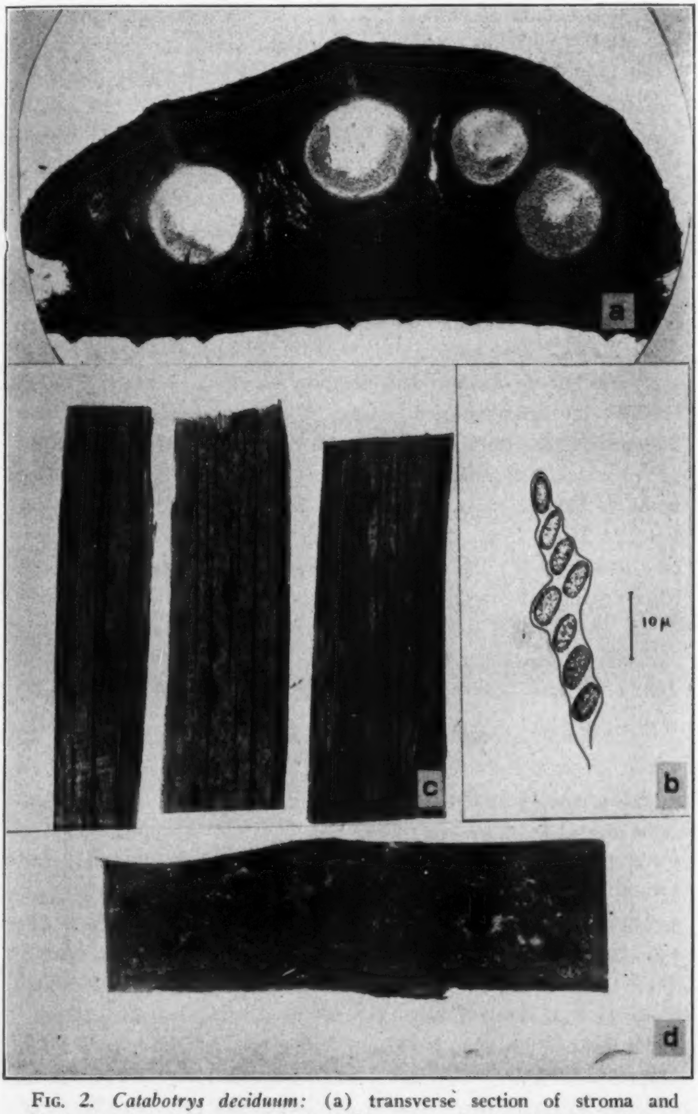

FIG. 2. *Catabotrys deciduum:* (a) transverse section of stroma and subiculum removed from substrate (*Musa* sp.), showing location of perithecia × 50; (b) single ascus with spores; (c) stromata on fallen petiole of *Musa* sp. × 1; (d) stromata on fallen petiole of *Sabal bermudana* × 1.

The Bermuda specimens also agree very well with published descriptions of *Bagnisiella palmarum* Pat., which was placed in the Dothideales by Patouillard (**1887**: 176, 177) who gave the spore range 6–7 × 3–4 μ. Theissen & Sydow (**1915**: 297, 298) later erected the genus *Catabotrys* Theiss. & Sydow for Patouillard's species and gave as their spore measurements 6.5–7.5 × 3 μ. Their illustration showing a section of the stroma (*loc. cit., Pl.* 2, *fig.* 5) compares well with our illustration (FIG. 2a). Petrak (**1934**: 339) emended the genus *Catabotrys* and transferred it to the Hypocreales where it would rightly appear to belong. The genus is represented by a single species for which the new combination given above is proposed.

The following Ascomycetes are new records: *Claviceps Paspali* Stevens & Hall, sphacelial stage on inflorescence of *Paspalum dilatatum* Poir., Pembroke, Oct. 12, 1921, *E. A. McCallan 34908* (*CU*); *Daldinia vernicosa* (Schw.) Ces. & De Not., on dead trunk of *Morus rubra* L., scorched by fire, St. George's Island, Feb. 22, 1944, *J. M. Waterston* (*GA*), det. J. H. Miller; *Hypocrea lenta* (Tode) Berk. & Br., on bark of *Juniperus bermudiana* L., Agricultural Station, Paget East, Jan. 26, 1926, *F. J. Seaver & H. H. Whetzel 34784* (*CU*); *Hypomyces candicans* Plowr., parasitic on sporangia and plasmodia of Myxomycetes during wet weather, Paget Marsh, November 1921, *H. H. Whetzel 34784* (*CU*).

BASIDIOMYCETES

The following Basidiomycetes are new records: *Agaricus cinchonensis* Murrill, on soil, King Edward VII Hospital Grounds, Paget East, Dec. 12, 1938, *F. J. Seaver & J. M. Waterston 191* (*NY*), det. A. H. Smith; *Cyphella cupulaeformis* Berk. & Rav., on bark of *Juniperus bermudiana* L., St. David's Island, May 22–June 6, 1914, *S. Brown, N. L. Britton & P. Bisset 2081* (*NY*), common after rain and represented by eight additional collections; *Hygrophorus laetus* Fries, at base of *Sabal bermudana* Bailey, Paget Marsh, Dec. 3, 1912, *S. Brown, N. L. Britton & F. J. Seaver 1312* (*NY*); *Lachnocladium semivestitum* Berk. & Curt., on leafmold under dense mat of *Jasminum gracile* Andrews, Walsingham, Jan. 20, 1922, *H. H. Whetzel* (*CNC*) and on soil,

near Trott's Pond, Feb. 5, 1926, *F. J. Seaver, H. H. Whetzel & L. Ogilvie B 41* (*CNC*), det. W. C. Coker as possibly the same as *Stereum proliferum* reported from Bermuda by Burt (**1920**: 116); *Lycoperdon epixylon* Berk. & Curt., on wood, Walsingham, Jan. 20, 1926, *F. J. Seaver, H. H. Whetzel & L. Ogilvie B 23* (*CNC*), det. W. C. Coker; *Pleurotus applicatus* (Batsch) Fries, on bark of *Juniperus bermudiana* L., following rain, Agricultural Station, Paget East, Oct. 16, 1940, *J. M. Waterston 299* (*NY*); *Ptychogaster cubensis* Pat., on *Myrica cerifera* L., growing from a knot-hole, Paget Marsh, Aug. 21, 1921, *H. H. Whetzel Bermuda Fungi No. 119*, det. R. Thaxter; *Scleroderma lycoperdoides* Schw., on soil among weeds, Agricultural Station, Paget East, Sept. 20, 1940, *J. M. Waterston 277* (*NY*), det. W. C. Coker; *Tulostoma pygmaeum* Lloyd, on soil, Grace's Island, Feb. 9, 1926, *F. J. Seaver & H. H. Whetzel 32623* (*CU*), det. W. C. Coker and reported previously only from Florida, Texas and Brazil.

FUNGI IMPERFECTI

CILIOSPORA GELATINOSA Zimm. (FIGS. 3, 4, 5)

On rotten petioles of *Archontophoenix Alexandrae* Wendel & Drude, Camden Marsh, opposite Rosebank, Paget East, associated with the stromata of *Helotium atrosubiculatum* Seaver & Waterston, Nov. 31, 1941, *J. M. Waterston 31508* (*CU*), det. H. H. Whetzel (**1942**: 529); same station and substrate, Jan. 22, 1943, *J. M. Waterston 32617* (*CU*); on rotting foliage of *Juniperus bermudiana* L., Trimingham's Hill, Paget East, held one month in moist chamber, Dec. 12, 1942, *J. M. Waterston 32614* (*CU*). Previously known only from Java on cacao pods. Petch (**1943**: 70) expresses doubt as to whether *Ciliospora* Zimm. is distinct from *Chaetospermum* Sacc. but we are assigning our specimens to the former genus until material of the latter can be obtained for study.

Spores from the *Archontophoenix* material measured 26–35 × 5–8 μ, with a mean of 28 × 5 μ, and those from *Juniperus* ranged from 21–33 × 5–8 μ with a mean of 26 × 5 μ. From this material, pure cultures were readily obtained by spore dilution on 2 per cent dextrose potato agar. Since it has grown and fruited readily in

artificial culture an opportunity was afforded to make a rather detailed study of a species of this peculiar and very interesting genus.

MORPHOLOGY

On its natural substrate, such as the fallen twigs of the juniper, the fruit bodies of *Ciliospora gelatinosa* appear as minute pearly-

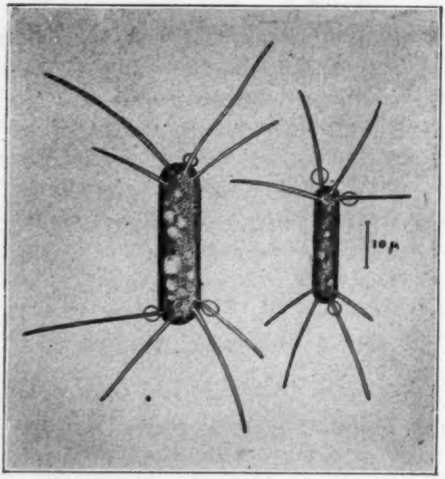

FIG. 3. Spore of *Ciliospora albida* from *Prunus serotina* (on left) compared with spore of *Ciliospora gelatinosa* from *Archontophoenix Alexandrae*.

white mucilaginous cushions, breaking forth through the ruptured epidermis of the leaves, usually a single fruit body from individual leaves, scattered here and there on the fallen branchlet. Removed on the tip of a needle, the base of the fruit body is seen to be deeply embedded in the leaf. It consists largely of a gelatinous mass of large appendaged, hyaline spores arising from a basal palisade of slender conidiophores embedded in a transparent, mucilaginous material. Enclosing this mass of spores and conidiophores is a very thin pinkish hyphal membrane of peculiar and characteristic pattern. This enclosing membrane is difficult to distinguish on fruit bodies from the juniper leaves but is quite obvious on fruit

bodies developed on agar. It is ruptured in irregular fissures as the spore-mass enlarges, appearing on mature fruit bodies as a pinkish collar about the basal portion. The conidia are cylindrical with rounded ends, slightly curved when observed lying on an uncurved side. Each conidium bears normally eight appendages arranged in two pairs near each end (FIG. 3). One pair is rather shorter and more slender and is attached somewhat farther from the end than the other pair. The members of each pair are attached to the spore opposite each other and alternate with those of the other pair. Each appendage usually bears a minute mucilaginous globule a short distance from its point of attachment. The appendages are rather broad at the base, tapering uniformly to a slender whip-like tip. The members of the two longer pairs are distinctly constricted for a short distance above the point of attachment. No such constriction has been observed in the members of the shorter pairs. The appendages are very transparent, shorter, and more difficult to see than are those of *Ciliospora albida,* but they are paired and attached to the body of the spore essentially as in that species. The longer appendages are about the length of the spore, 22–25 μ. The shorter ones are about 15–18 μ in length. Each spore is surrounded by a thin mucilaginous sheath. Basic fuchsin in aqueous solution stains the cytoplasm of the spore deep red and the appendages a faint pink. The mucilaginous envelope, however, is not readily stained.

Pycnidia and spores were readily produced on 2 per cent dextrose agar. Measurement of 200 spores produced in culture (No. *32617*) gave a range of 21–31 × 4–7 μ, with a mean of 25.7 × 5.2 μ. These measurements conform closely with those given by Zimmerman (**1902**: 217) for his species *C. gelatinosa* (15–30 × 5–6 μ). Whetzel (**1942**: 528) has shown that these measurements are definitely shorter than those recorded for *C. albida* (28–40 × 6–12 μ, average 35 × 10 μ).

In order to clear up any possible confusion of the Bermuda species with *C. albida,* fresh material of the latter was sought by the junior author at Lloyd Preserve, McLean, New York, at the same station where H. H. Whetzel and J. Niederhauser made the first collection in North America, Dec. 2, 1941 (Whetzel **1942**: 525). Fallen leaves of *Prunus serotina* Ehrh., stromatized by *Rut-*

stroemia Pruni-serotinae Whetzel & White, were collected on November 4, 1944. These were placed in a moist chamber and thirty-six days later a few pycnidia were first seen on the upper surface of the leaves. Spore production was abundant, and no difficulty was experienced in getting the fungus in pure culture. A dried specimen of this collection made by the junior author is preserved in the Cornell University Plant Pathology Herbarium as No. *35003*.

Both species of *Ciliospora* grew well on non-acidified 2 per cent dextrose potato agar. *C. albida* from the *Prunus* leaves made no growth at temperatures above 27° C. At 23° C. growth was submerged (FIG. 4, upper). The optimum rate of growth for this species was obtained at 21° C. and was accompanied by the production of a dense, white, cottony aerial mycelium, which turned a light buff color with age (FIG. 5, upper). Very few pycnidia were formed in plate cultures and then only after 4 weeks growth. Some tube cultures, twenty-one days old, produced a few pycnidia where the mycelium was in contact with the glass wall and at a temperature of 21° C. The spores produced compared favorably in size with field material.

C. gelatinosa from the *Archontophoenix* leaves was found to have a higher optimum temperature for growth around 27° C., as one would expect from a fungus found in a subtropical habitat. The Bermuda isolate grew readily on 2 per cent dextrose potato agar, with or without acidification with phthallic acid (pH 4.5) but refused, as did *C. albida,* to grow on this same medium acidified with lactic acid. Growth was rapid and very characteristic. The mycelium was almost entirely submerged but restricted to the upper millimeter or so of the media. The aerial hyphae were sparse, fibrillose appressed and never cottony as in *C. albida*. Growth was finely zonate, there being 30–40 narrow zones in a thallus covering an ordinary petri dish (FIG. 4, lower).

FIG. 4. (upper) Plate culture of *Ciliospora albida* isolated from leaves of *Prunus serotina,* grown at 23° C., on 2 per cent dextrose potato agar, 14 days old, no zonation and pycnidia absent. (lower) Plate culture of *Ciliospora gelatinosa* isolated from petiole of *Archontophoenix Alexandrae,* grown at 23° C., on 2 per cent dextrose potato agar, showing abundant formation of pycnidia and spores when 14 days old. Note zonation.

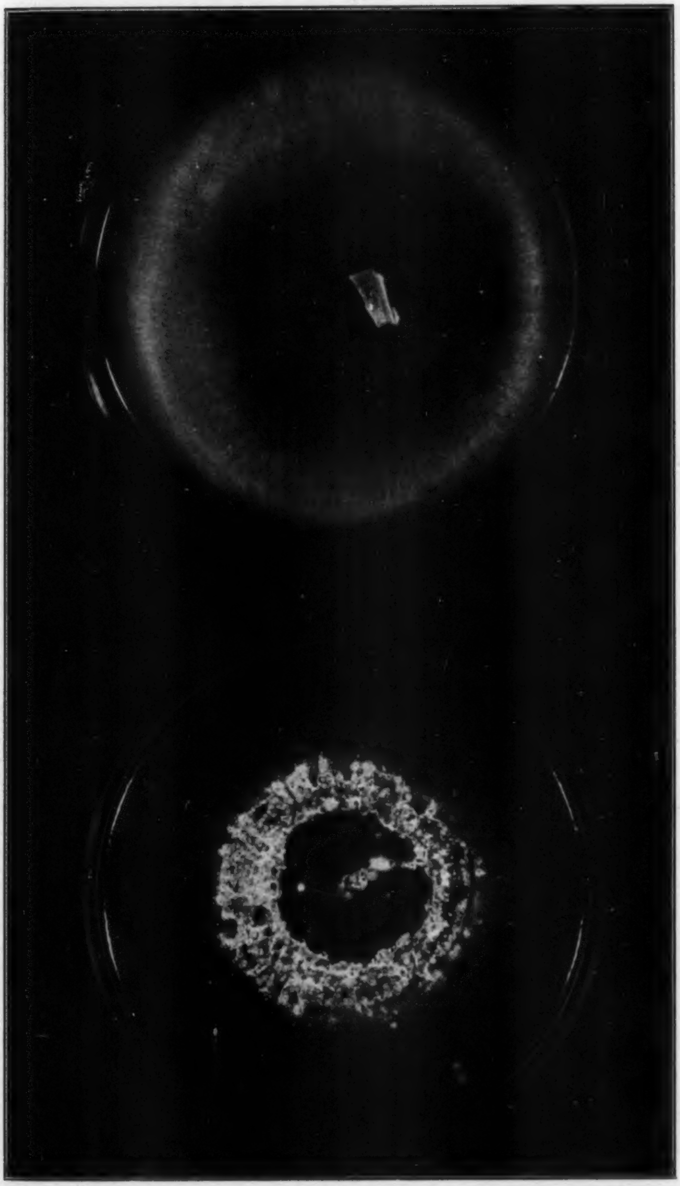

FIG. 4.

Fruit body initials appeared in less than a week, at first submerged, they eventually emerged as small (1–2 mm. diam.), hemispherical, cottony-white cushions, zonately arranged. The cottony hyphae finally collapse as the spore mass bursts the enveloping pinkish colored membrane. When the culture is ten to fourteen days old the fruit body appears as a pearly-white globule with a pinkish collar about its base. The pycnidia are often found aggregated in groups.

The fungus also fruited well on sterilized cellulose beer-glass coasters similar to those used by Tyler & Parker (**1945**: 258) for culturing *Ceratostomella Ulmi*. The pads were soaked in a potato extract solution before introducing the fungus inoculum (FIG. 5, lower). *C. albida* was grown on the same substrate but failed to produce pycnidia.

C. gelatinosa therefore appears to differ quite markedly from *C. albida* both in morphological and physiological characters. The readiness with which the former grows and fruits on dextrose potato agar makes it a desirable species for laboratory teaching. We shall be glad to distribute cultures of it on request as long as we have it available.

Macrophoma Lilii sp. nov. (FIG. 6)

Pycnidia globosa, 160–210 μ in diametro, ostiolo distincto, rotundo, non-papillato, 20–35 μ in diametro, a superiore marginem nigrum exhibenti; sporophorae 12–15 × 2–3 μ, crassae, simplices, in longitudine sporas paene aequantes; sporae 15–23 × 3–7 μ, plerumque 18 × 6 μ, hyalinae, non-septatae, fusiformes vel claviformes, extremis obtusis, rectae, plerumque eguttulatae.

Pycnidia globose, 160–210 μ diam., with distinct, round, non-papillate ostiole, 20–35 μ diam., showing a black rim when viewed from above; sporophores 12–15 × 2–3 μ, stout, simple, almost as long as the spores; spores range from 15–23 × 3–7 μ, average 18 × 6 μ, hyaline, non-septate, fusiform to clavate, with blunt pointed ends, straight, mostly eguttulate.

FIG. 5. (upper) Plate culture of *Ciliospora albida* isolated from leaves of *Prunus serotina*, grown at 21° C., on 2 per cent dextrose potato agar, 14 days old. Note abundance of cottony aerial mycelium and absence of pycnidia. (lower) *Ciliospora gelatinosa* isolated from petiole of *Archontophoenix Alexandrae*, grown at 27° C., on cellulose pad saturated with potato extract, 14 days old. Pycnidia and spores abundant.

FIG. 5.

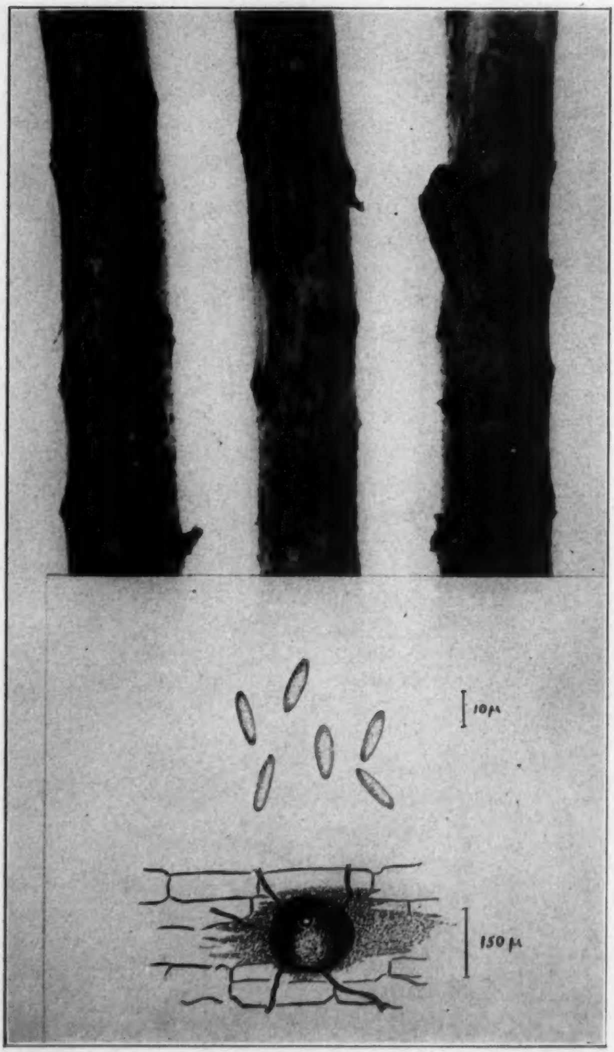

FIG. 6. Dead stems of *Lilium longiflorum* var. *eximium*, showing pycnidia of *Macrophoma Lilii* × 2.

On dead stems of *Lilium longiflorum* var. *eximium* Baker, Agricultural Station, Paget East, June 1921, *H. H. Whetzel 35123* (*CU*), (type).

This species occurs commonly on dead stems of the Bermuda Easter lily during early summer after the plants have matured or have died back from some other cause. The flowering stalks are covered with the black pimple-like pycnidia and have the appearance of having been bleached almost white.

The fungus was isolated by Dr. G. R. Bisby from material collected by the junior author in 1938. The cultures were found to be slow in producing pycnidia and spores. The latter, when produced, ranged from 15–20 × 6–7 μ and showed a close correlation in size with those produced on lily stems in the field. Although the spores are typically non-septate, Dr. Bisby found some which suggested that septa might eventually be formed.

No fungus has previously been described on lily in Europe or America which will fit this species. It is distinct from *Macrophomina Phaseoli* previously recorded from lily roots in Bermuda by Ogilvie (**1928**: 35).

Macrophoma Trichostomi sp. nov. (FIG. 7)

Pycnidia globosa, 150 μ in diametro, ostiolo parvo, circulari, 20 μ in diametro, margine definito nigro; sporae modorum duorum, magnae 18 × 4 μ, et parvae 7 × 2 μ, hyalinae, cylindratae vel claviformes, plerumque rectae.

Pycnidia globose, 150 μ diam., with a small circular ostiole, 20 μ diam., surrounded by a definite black margin; spores distinctly of two sizes, large ones 18 × 4 μ, and small ones, 7 × 2 μ, hyaline, cylindrical or clavate, usually straight.

Parasitic on capsules of the endemic moss, *Trichostomum bermudianum* Mitt., Paget East, Feb. 10, 1922, *H. H. Whetzel 35119* (*CU*), (type).

This interesting little species has been collected only once in Bermuda, where it was found attacking a large percentage of moss capsules before they were fully developed. There are apparently no previous records of Phoma-like fungi on any North American moss and none has been reported heretofore on the genus *Trichostomum*. There are a group of *Phoma* spp. reported on moss capsules in Europe which have small spores ranging 3–6 × 1–2 μ.

These are *Phoma muscorum* Rostrup (**1903**: 318), *Phoma Splachni* Rostrup (**1904**: 30), *Phoma muscicola* Smith (**1910**: 221) and *Phoma Orthotrichi* Smith & Ramsbottom (**1914**: 326). According to Grove (**1935**: 121) the latter is a young stage of *P. muscicola*. None of these species appears to produce the large spores characteristic of the Bermuda species.

Phyllosticta Casaresi Gonzalez (**1916**: 369) on moss leaves, has spores 14–22 × 3.5–5 μ and most closely approaches the Bermuda species. It is, however, a foliicolous species and is not recorded on capsules. There is no mention either, in the original description, of the presence of microspores. The writers have accordingly felt justified in erecting a new species for the Bermuda fungus.

Schizotrichum Conocarpi sp. nov. (FIG. 8)

Sporodochia gregaria, cylindrata vel subglobosa, superficialia, nigra, 75–150 μ in diametro, 200–250 μ alta, setis similiter coloratis, projicientibus, parietibus crassis, simplicibus, septatis, ad septa haud constrictis, ad extrema acutis, concoloratis, 200–600 × 7 μ; conidiophorae obsoletae; conidia hyalina, filiformia, recta vel curva, 6–8-septata, ad septa haud constricta, guttulata, in longitudine variabilia pro numero septorum, ea 6-septata 57 × 3 μ, ea 7-septata 60–72 × 3 μ, ea 8-septata 75–84 × 3 μ.

Sporodochia gregarious, cylindrical to sub-globose, superficial, black, 75–150 μ diam., 200–250 μ high, with similarly colored, projecting, thick-walled setae, simple, septate, not constricted at septa, pointed at tips, concolorous, 200–600 × 7 μ; conidiophores obsolete, conidia hyaline, filiform, straight or curved, 6–8 septate, not constricted at septa, guttulate, variable in length according to the number of septa, those 6-septate are 57 × 3 μ, those 7-septate range from 60–72 × 3 μ, those 8-septate range from 75–84 × 3 μ.

On fallen, decaying leaves of *Conocarpus erecta* L., Walsingham, Jan. 22, 1926, *L. Ogilvie 35120* (*CU*), type; at same station and on same substrate, Jan. 19, 1943, *J. M. Waterston 35121* (*CU*).

The genus *Schizotrichum* was erected by McAlpine (**1903**: 562) for the monotypic species *S. Lobeliae* McAlpine, with setae 70–95 ×4.5–5 μ and spores 3–6 septate and ranging 28–35 (with some 50–60 μ) × 1–2 μ. The Bermuda fungus differs from the Australian species in possessing far longer setae and spores. The

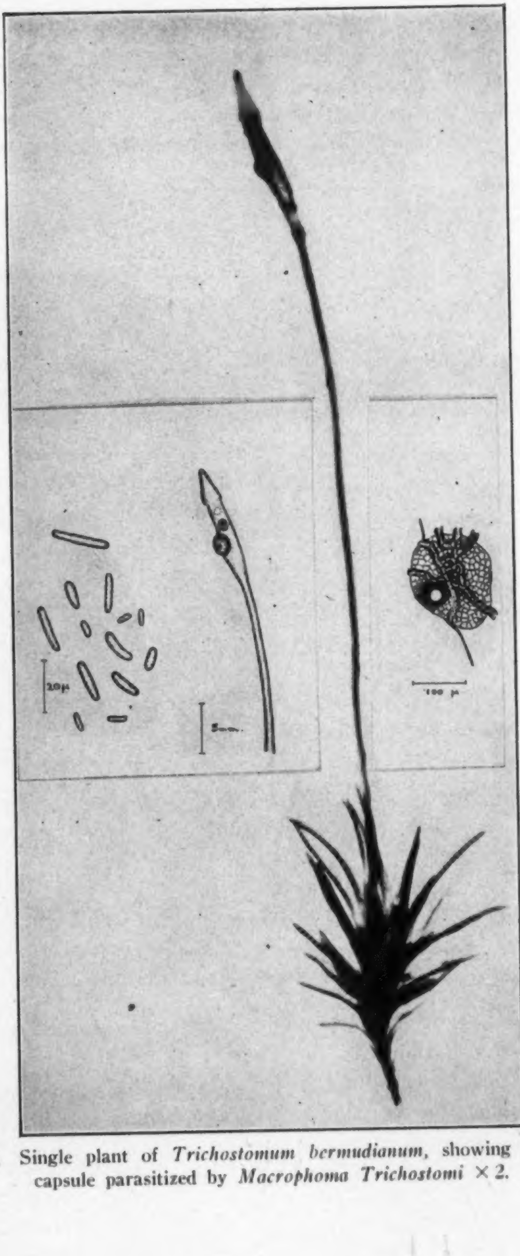

FIG. 7. Single plant of *Trichostomum bermudianum*, showing immature capsule parasitized by *Macrophoma Trichostomi* × 2.

hyphae connecting the sporodochia do not appear to be as prominent as in McAlpine's species.

The second collection by the junior author, although taken at the same station as the type, was made without knowledge of Ogilvie's collection, which was discovered in the Herbarium at

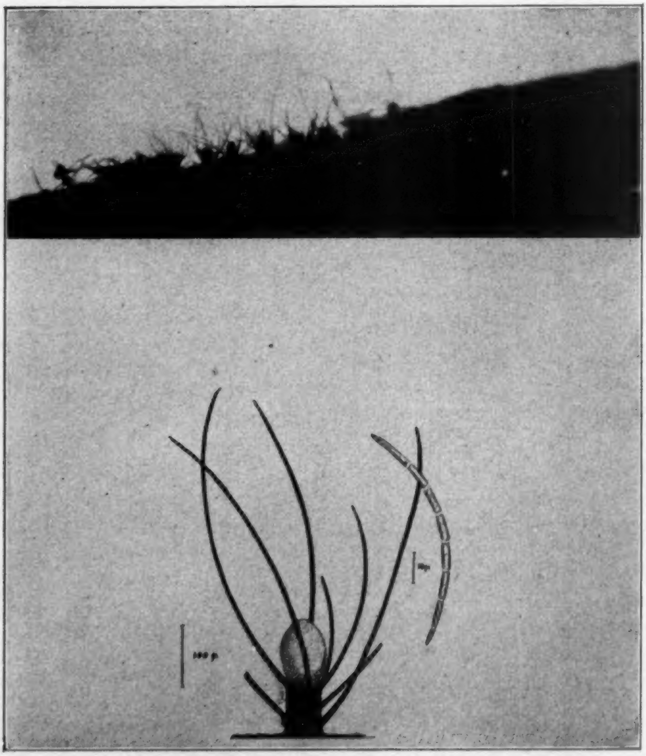

FIG. 8. *Schizotrichum Conocarpi:* (upper) natural habit × 15; (lower) sporodochium and spore.

Cornell University. This would indicate that the species is well established in Bermuda.

Interesting species of Fungi Imperfecti hitherto unrecorded from Bermuda are as follows: *Brencklea Sisyrinchii* (Ell. & Ev.) Petrak, on leaves of *Sisyrinchium bermudianum* L., Paget, March

1922, *H. H. Whetzel 34973* (*CU*), previously known from Berkeley, California, Washington County, N. Y., and North Dakota; *Colletotrichum Lilii* Plakidas, on dead stems of *Lilium longiflorum* var. *eximium* Baker, Agricultural Station, Paget East, June 15, 1921, *H. H. Whetzel 34959* (*CU*); *Exosporium Leucaenae* Stevens and Dalbey, on leaves of *Leucaena glauca* (L.) Benth., Walsingham, Jan. 21, 1926, *H. H. Whetzel & L. Ogilvie Bermuda Fungi No. 200,* previously known only from Puerto Rico; *Myrothecium roridum* Tode ex Fries, on weathered shell of fruit of *Crescentia Cujete* L., Smith's Parish, Dec. 9, 1938, *F. J. Seaver & J. M. Waterston 173 L* (*NY*), known only as a saprophyte in Bermuda; *Myrothecium verrucaria* (Alb. & Schw.) Ditmar ex Fries, on weathered cardboard, Shelly Bay, Mar. 30, 1939, *J. M. Waterston 251* (*NY*); *Pestalotia adusta* Ell. & Ev., on leaves of loquat, *Eriobotrya japonica* Lindl., Devonshire, October 1927, *L. Ogilvie 35229* (*CU*), det. E. F. Guba; *Pestalotia longi-aristata* Maubl., on fruit of loquat, *Eriobotrya japonica* Lindl., Agricultural Station, Paget East, February 1922, *H. H. Whetzel 35228* (*CU*), det. E. F. Guba; *Pestalotia vermiformis* Massee, associated with die-back of stems of *Barringtonia speciosa* Forst., Agricultural Station, Paget East, June 7, 1929, H. S. Cunningham, det. E. F. Guba; *Phleospora Dodonaeae* Nattrass, on leaves of *Dodonaea jamaicensis* DC., St. David's Island, Dec. 16, 1940, *J. M. Waterston 428* (*NY*), *35036* (*CU*), previously known only from Cyprus; *Phoma polygramma* Sacc., on dead peduncles of *Plantago lanceolata* L., South shore, Devonshire, March 1922, *H. H. Whetzel 34970* (*CU*); *Phomopsis Malvacearum* (West.) Grove, on stem of *Hibiscus Sabdariffa* L., Agricultural Station, Paget East, *J. M. Waterston 35016* (*CU*), spores $6–8 \times 1\ \mu$, "b" spores, $18–21 \times 1\ \mu$; *Spegazzinia ornata* Sacc., on old leaves of crab-grass, *Stenotaphrum secundatum* (Walt.) Kuntze, opposite Paynter's Vale, Walsingham, Jan. 21, 1926, *H. H. Whetzel 35010* (*CU*); *Sphaerosporium lignatile* Schw., on rotten wood in slat-house, Agricultural Station, Paget East, Dec. 11, 1940, *J. M. Waterston 35220* (*CU*), det. D. H. Linder; *Sporendonema epizoum* (Corda) Ciferri & Redaelli, on stale gingerbread, Pembroke, June 14, 1943, J. M. Waterston, det. E. W. Mason; *Stachybotrys subsimplex* Cooke, on fallen leaves of *Musa* sp., Hungry Bay, Dec. 2, 1938,

F. J. Seaver & J. M. Waterston 80b (*NY*), det. E. W. Mason; *Stephanoma tetracoccum* van Zinderen—Bakker, parasitic on *Geoglossum nigritum* Cooke, Harrington Sound, Dec. 7, 1912, *S. Brown, N. L. Britton & F. J. Seaver 1564* (*NY*); *Trichothecium Helminthosporii* (Thüm.) Sacc., parasitic on *Helminthosporium Ravenelii* Berk. & Curt., on *Sporobolus Berteroanus* (Trin.) Hitch. & Chase, Paget Marsh, Sept. 25, 1921, *H. H. Whetzel Bermuda Fungi No. 177; Ustilaginoidea Dichromenae* P. Henn., in ovaries of *Dichromena colorata* (L.) Hitch., Paget Marsh, Aug. 12, 1921, *O. Degener Bermuda Fungi No. 27,* det. H. M. Fitzpatrick.

ACKNOWLEDGMENTS

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LITERATURE CITED

Berkeley, M. J. & Broome, C. E. 1875. Enumeration of the fungi of Ceylon. Jour. Linn. Soc. **14**: 120.

Boedijn, K. B. 1932. The genus *Sarcosoma* in Netherlands India. Bull. Jard. Bot. Buitenzorg III. **12**: 273–279.

Burt, E. A. 1920. The Thelephoraceae of North America XII. Ann. Missouri Bot. Garden **7**: 116.

Cooke, M. C. 1883. *Hypoxylon* and its allies. Grevillea **11**: 123.

Gonzalez Fragoso, R. 1916. Hongos sobre muscineas *in* Bol. Soc. Españ. Hist. Nat. **16**: 369.

Grove, W. B. 1935. British stem- and leaf-fungi, Vol. **1**, p. 121.

Kevorkian, A. G. 1937. Studies in the Entomophthoraceae I. Observations on the genus *Conidiobolus*. Jour. Agr. Univ. Puerto Rico **21**: 191–200.

Martin, G. W. 1942. Notes on Iowa fungi. IX. Proc. Iowa Acad. Sci. **49**: 145, 146.

McAlpine, D. 1903. Australian fungi, new or unrecorded. Decades V–VII. Proc. Linn. Soc. New South Wales **28**: 553–563.

Ogilvie, L. 1928. Report of the Plant Pathologist for the year 1927. Bermuda Rept. Dep. Agr. for the year **1927**: 26–37.

Patouillard, N. 1887. Champignons de la Nouvelle-Calédonie. Bull. Soc. Myc. Fr. **3**: 168–178.

Petch, T. 1910. Revisions of Ceylon fungi. Ann. Roy. Bot. Garden Peradeniya **4**: 420–422.

——. 1924. Xylariaceae zeylanicae. Ann. Roy. Bot. Garden Peradeniya **8**: 119–166.

——. 1943. British Nectrioideae and allied genera. Trans. Brit. Myc. Soc. **26**: 53–70.

Petrak, von F. 1934. Mykologische Notizen XII. Ann. Myc. **32**: 337–339.

Rostrup, F. G. E. 1903. Islands Svampe. Bot. Tidsskrift **25**: 318.

——. 1904. Vidensk. Selskab. Skrift. **1**: 1–44.

Seaver, F. J. 1928. The North American cup-fungi. New York.

——. 1942. *Ibid.* Supplement.

Seaver, F. J. & Waterston, J. M. 1940. Contributions to the mycoflora of Bermuda—I. Mycologia **32**: 388–407.

——. 1941. *Ibid.* II. Mycologia **33**: 310–317.

——. 1942. *Ibid.* III. Mycologia **34**: 515–524.

Smith, A. L. 1910. New or rare microfungi. Trans. Brit. Myc. Soc. **3**: 221.

Smith, A. L. & Ramsbottom, J. 1914. New or rare microfungi. Trans. Brit. Myc. Soc. **4**: 326.

Theissen, von F. & Sydow, H. 1915. Die Dothideales. Ann. Myc. **13**: 149–746.

Tyler, L. J. & Parker, K. G. 1945. Phytopathology **35**: 258.

Whetzel, H. H. 1942. *Ciliospora albida.* Mycologia **34**: 525–531.

White, W. L. 1937. Note on *Conidiobolus.* Mycologia **29**: 148–149.

Zimmermann, A. 1902. *Ciliospora* gen. n. *in* Ueber einige an tropischen Kulturpflanzen beobachtete Pilze II. Centralb. Bakt. **2**: **8**: 217.

NEW SPECIES OF PORIA[1]

L. O. Overholts and J. L. Lowe

(with 2 figures)

In the course of independent studies of miscellaneous collections of fungi of the genus *Poria* (Family *Polyporaceae*) and the timber decays produced by them, the authors have found apparently undescribed species, which are here proposed as new. One of these was segregated but never published by another author; two are independently proposed; and four are jointly proposed by the two authors as they were duplicated in our individual collections. The junior author is responsible for the Latin descriptions, except for that of *Poria carbonica,* which was prepared by Dr. Robert E. Dengler, Professor of Classical Languages, The Pennsylvania State College.

Color names within quotation marks are from R. Ridgway, *Color Standards and Color Nomenclature,* Washington, D. C., 1912.

Poria alutacea Lowe, n. sp. (fig. 1, B)

Annua, effusa ad 5 cm., membranacea-coriacea, facile separabilis, nec odore nec gustatu distincta; margine alba, byssina et implicita, vel lata vel angusta, rhizomorphae plerumque adsunt; superficie pororum alba vel pallida et cremea, leviter nitida; tubulis ad 0.5 mm. longis, in statu sicco subericis; poris rotundis vel angulatis, 5–6 singulis plerumque in uno mm., dissaepimentis demum modice tenuibus, acie integra vel fimbriata; clavis hyphatis nullis; cystidiculis maiorem partem immersis, obtusis, diametro 4–5 μ; basidiis late clavatis, 8–10 $\times$ 4–5 μ; sporis hyalinis, levibus, cylindratis, rectis vel leviter curvatis et tunc late allantoideis, 2.5–3.5 $\times$ 1.5 μ; subiculo albo, ad 0.1 mm. crasso, firmo, ex hyphis coniuncte intertextis, rare ramosis, maiorem partem solidis, diametro 1.5–2 μ; saeptis autem nullis, et, cum premuntur, non facile separabilibus; hyphis tramarum similibus.—In ligno coniferarum et deciduarum, specimen typicum prope Tully, N. Y. collectum a J. L. Lowe (n. 2701), et in herbario Farlowiano in Universitate Harvardiana conser-

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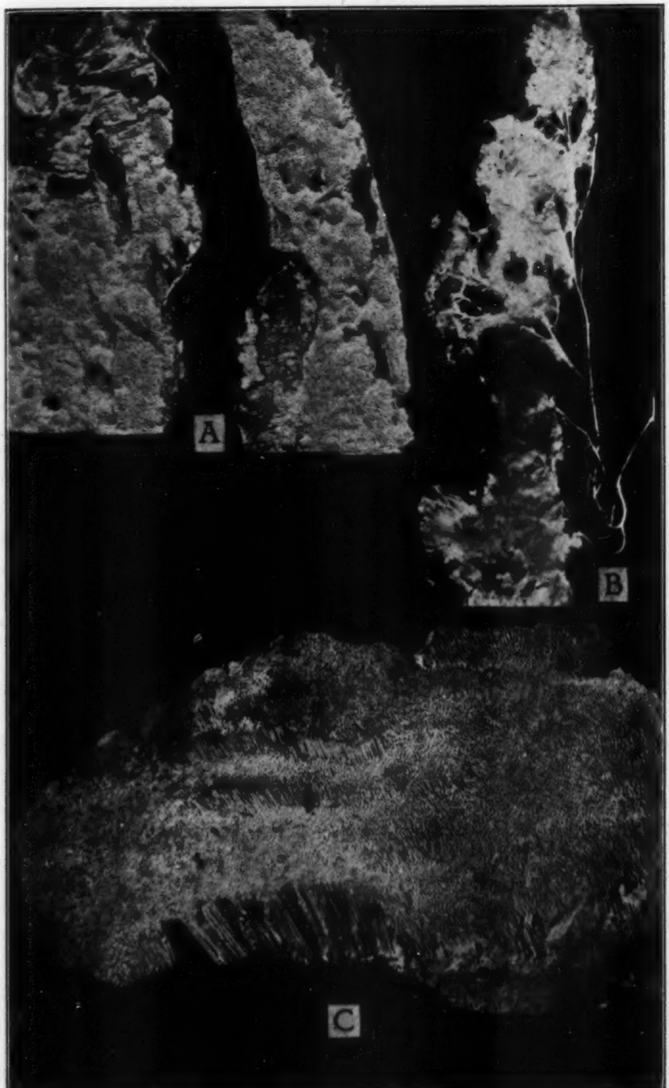

Fig. 1. A, *Poria lenta* × 1 (Catskill Mts., Peck); B, *Poria alutacea* × 1 (type, Lowe 2701); C, *Poria carbonica* × 2 (type, Overholts 22021).

vandum. Id exemplum consimile est *Poriae fimbriatellae* (Peck) Sacc., sed cystidiis nullis, poris et hyphis subiculi minoribus et sporis cylindratis nec ellipsoideis.

Annual, effused up to 5 cm., membranous-tough, readily separable, without distinct taste or odor; margin white, matted-mycelioid, wide or narrow, usually with well-developed rhizomorphs; pore surface white to pale cream, slightly glancing; tubes up to 0.5 mm. long, corky when dry; pores rounded or angular, averaging five to six per mm., the dissepiments becoming moderately thin, entire to fimbriate; hymenium without hyphal pegs so far as seen; cystidioles mostly immersed, bluntly pointed, 4–5 μ diameter; basidia broadly clavate, 8–10 × 4–5 μ; spores hyaline, smooth, short-cylindric, straight, or slightly curved and then appearing somewhat broad-allantoid, 2.5–3.5 × 1.5 μ; subiculum white, about 0.1 mm. thick, firm, the hyphae closely interwoven, sometimes incrusted, rarely branched, mostly solid, 1.5–2 μ diameter, without cross walls, difficultly separable under pressure; tramal hyphae similar.

On the wood of coniferous and deciduous trees; Tully, N. Y., Lowe 2701 (type); also Lowe 2643 and 2702; known also in New York from Saratoga Lake (H. D. House), and from Warrensburg, Lowe 1826, 2361; from Lake Timagami, Ontario (R. F. Cain), and by sporophores sterile but otherwise agreeing, from Pennsylvania, Lowe 2761, and North Carolina (F. O. Grover). The plant is similar to *Poria fimbriatella* (Peck) Sacc. but lacks large cystidia, the pores are slightly smaller, the subiculum hyphae more slender, and the spores are not ellipsoid.

Poria carbonica Overholts, n. sp. (FIG. 1, C)

Effusa ad aliquot centimetra, annualis, vel si rediviva per secundum annum tubulis saltem non laminatis, 3–12 mm. crassa, margine tenui vel interdum subtumescenta, superficie in substratis verticalibus plus minusve nodulosa, tenax et caseata, valde dura ut siccatur, alba vel senescens isabellina; tubulis 2–10 mm. longis, longioribus obliquis, oribus 3–4 per mm., muris aliquantum crassis et integris, interdum tenuibus hiantibusque; subiculo bene formato, albo, firmo, nullo modo fibroso, 0.5–3 mm. crasso; sporis anguste ellipsoideis vel paene breviter cylindricis, levibus, hyalinis, 3.5–6 × 2–3 μ; basidiis clavatis, 10–12 × 4.5–6 μ; hyphis subiculi valde congelatis (vel saltem non tinctis, saepe lumine solum viso), 3–4 μ diam., aliquantum ramosis, quibusdamque saeptis et fibulis instructis; hyphis tramae 2–2.5 μ diam. et distinctioribus.

Hab. In ligno mortuo et saepe ambusto arborum coniferarum. Specimen typicum in stipite conifero Aug. 31, 1938, Saanichton, Brit. Columbiae, a Dr. Irene Mounce et Jean Straight repertum est et in herbario Overholtsii (n. 22021) conservandum.

Effused for several centimeters, annual or if reviving for more than one season at least the tubes not in layers, 3–12 mm. thick, the margin thinning out or at times a bit tumid, on vertical substrata the surface more or less nodulose with the tubes vertical, cheesy-tough when fresh, drying quite hard, white or in age isabelline; tubes 2–10 mm. long, the latter lengths where oblique, the mouths three to four per mm., the walls rather thick and entire, at times becoming thin and gaping; subiculum well developed, white, firm, not at all fibrous, 0.5–3 mm. thick; spores narrow-ellipsoid or almost short-cylindric, smooth, hyaline, $3.5–6 \times 2–3\ \mu$; basidia clavate, $10–12 \times 4.5–6\ \mu$; subiculum hyphae with walls considerably gelatinized (or at least unstaining and often only the lumen visible), $3–4\ \mu$ diameter, somewhat branched, with some cross walls and clamps, those of trama $2–2.5\ \mu$ diameter and more distinct.

On dead and often charred wood of coniferous trees. Type collected on coniferous log at Saanichton, British Columbia, August 31, 1938, by Dr. Irene Mounce and Jean Straight (Overholts Herb. 22021). The following additional collections are in Overholts Herbarium: on end of burned log of *Pseudotsuga taxifolia* (Poir.) Brit., Cook Creek, Vancouver Isl., August 18, 1938, I. Mounce (84444); on *Picea Engelmanni* (Parry) Engelm., Upper Priest River, Idaho, August 1, 1924, C. R. Stillinger (1838); on *Pinus ponderosa* Dougl., Missoula, Mont., Sept., 1916, J. R. Weir (4169); on *Pseudotsuga taxifolia,* Carson, Wash., October 29, 1935, G. H. Englerth (58033); on *Pseudotsuga taxifolia,* Siuslaw National Forest, Oregon, Sept. 23, 1938, Englerth and Childs (94012); under side of drift log, Kaloma, Wash., Oct. 12, 1909, C. J. Humphrey (5905); on *Tsuga heterophylla* (Raf.) Sarg., Revelstoke, B. C., Aug. 26, 1930, J. R. Hansbrough (40652); on *Pseudotsuga taxifolia* boat timber, Seattle, Wash., May 15, 1942, G. H. Englerth (94160) comm. R. W. Davidson; on *Pseudotsuga taxifolia,* Vancouver Isl., British Columbia, Aug. 6, 1942, J. E. Bier (V-1640); *ibid.,* Sept. 2, 1942 (V-162); Coyote Creek, Lane Co., Ore., Oct. 22, 1939, Maxwell Doty.

This is Poria no. 36 in W. B. Cooke's paper,[2] as evidenced by specimens sent by Dr. Maxwell Doty. Cooke cites 12 additional collections, all from Oregon, and all on *Pseudotsuga.* The associated rot is usually of the brown carbonizing type.

[2] Amer. Midland Nat. **27**: 692. 1942.

Poria bombycina (Fries) Cooke. (FIG. 2, E)

After this manuscript was submitted the collections cited below were found to agree with *Polyporus hians* Karst., No. 619 in Fungi Fenniae Exsic., a synonym of *P. bombycina* according to Bresadola and Pilát. No other American collections are known to the authors. As a description in English has not been found, one is included here.

Annual, effused up to 5 cm., readily or difficultly separable, without odor; margin white, sometimes changing to tawny on drying, fibrous or mycelioid, narrow to wide; pore surface grayish-white or pale yellowish-orange to pale pinkish-brown, becoming pale pinkish-brown on drying; tubes up to 1 mm. long, soft, soft-fragile when dry; pores circular to elongated and somewhat sinuous, averaging two to three per mm., the dissepiments remaining rather thick, entire; hymenium distinct from the trama, without cystidia; basidia broadly clavate, with clamp connections at the base, 15–22 × 5–8 μ; spores ellipsoid or oblong-ellipsoid, smooth, hyaline or with a faint yellow tinge, 6–7.5 × 3.5–4 μ; subiculum tawny when dry, fine-fibrous, up to 0.2 mm. thick, the hyphae loosely interwoven, thin-walled, 2–4 μ diameter, rarely to moderately branched, with frequent clamps, also with cross walls, continuous without change into the trama, readily separable by pressure; tramal hyphae similar.

On the wood of coniferous trees, Warrensburg, N. Y., Lowe 2225 and 2504, North Elba, Peck; N. Hamp., Farlow; and from Gull Lake, Timagami Nat. Forest, Ontario, Canada, S. M. Pady (Overholts Herb. 17072 and Herb. Univ. Toronto 4037). The plant resembles *Poria Vaillantii* (Fries) Cooke but is not rhizomorphic and changes color on drying.

Poria fissiliformis Pilát in litt., n. sp.

Annua, effusa ad 30 cm. vel ultra, plerumque coriacea, in statu sicco dura et fragilis, plerumque facile separabilis, nec odore nec gustatu distincta; margine alba vel lutea, radiata-fimbriata vel implicita, latiore et conspicua; superficie pororum vel cremea vel lutea, sed in sicco eadem est vel obscurans ad helvam colorem; tubulis ad 6 mm. longis, in statu sicco vitreis et fragilibus, poris 5–8 singulatis plerumque in uno mm., angulatis, acie tenui, integra vel fimbriata; cystidiis frequentibus vel raris, conicis, partim immersis ad 7 μ diametro, cystidicula aliquando adsunt; basidiis clavatis, 8–11 × 4–4.5 μ; sporis hyalinis, levibus, oblongis vel ellipsoideis, 2.5–5 × 1.5–2.5 μ; subiculo albo vel

pallido et cremeo, ad 0.2 mm. crasso, in statu sicco verum fibrato et fragili, ex hyphis laxe vel coniuncte intertextis, crasse tunicatis, modice ramosis, non saeptatis, nec non hyphis tenuiter tunicatis et fibulatis, diametro 3–5 μ, et cum premuntur, non facile separabilibus; hyphis tramarum tenuiter tunicatis, non-saeptatis, diametro 2–2.5 μ.—In ligno deciduarum, specimen typicum in *Acere* prope Creve Coeur Lake, Missouri, a L. O. Overholts collectum, et in herbario Overholtsii (n. 19780) conservandum. Id exemplum consimile est *Poriae subacidae* (Peck) Sacc., sed sporis et poris minoribus.

Annual, effused up to 30 cm. or more, leathery or sometimes crisp when fresh, drying hard and brittle, usually readily separable, without distinct odor or taste; margin white to buff, radiate-fimbriate or matted, rather wide and conspicuous; pore surface cream to pale yellow-orange, drying pale cream to light orange, or "apricot buff," glancing, the tubes up to 6 mm. long, glassy-fragile when dry, the pores averaging five to eight per mm., angular, the dissepiments thin, edges entire to fimbriate; hyphal pegs rarely present; cystidia obscure, frequent to rare, conic, partially immersed, up to 7 μ diameter; cystidioles sometimes present; basidia clavate, 8–11 × 4–4.5 μ; spores hyaline, smooth, short-oblong to ellipsoid, 2.5–5 × 1.5–2.5 μ; subiculum white to pale cream, up to 0.2 mm. thick, fibrous-fragile when dry, the hyphae loosely or compactly interwoven, a mixture of thick-walled, moderately branched, aseptate hyphae and of thin-walled hyphae with clamps, 3–5 μ diameter, difficultly separable with pressure; trama continuous with the subiculum, the hyphae rather thin-walled, without septa, 2–2.5 μ diameter, at juncture of tubes with a variable amount of thick-walled, rarely branched aseptate hyphae, 2.5–5 μ.

On the wood of deciduous trees; type collected on *Acer* at Creve Coeur Lake, Missouri, by L. O. Overholts, and deposited in the Overholts Herbarium (n. 19780); known also in New York from Newcomb, Lowe 2351, from Tully, Lowe 2679, 2716, 2726, 2746, and from Warrensburg, Lowe 2247, 2351, Carlberg 39 and 53; from Vermont (P. Spaulding), and from Manitoba (G. R. Bisby). The plant has the aspect of *Poria subacida* (Peck) Sacc. but has smaller spores and pores.

Poria illudens Overholts and Lowe, n. sp. (FIG. 2, D)

Annua, effusa ad 8 cm., coriacea, in statu sicco suberica, vel facile vel difficile separabilis, nec gustatu nec odore distincta; margine angusta et fimbriata, concolore superficie pororum, quae est cremea vel leviter lutea, in statu sicco similis vel leviter obscurans, sordida vel nitida; tubulis ad 4 mm.

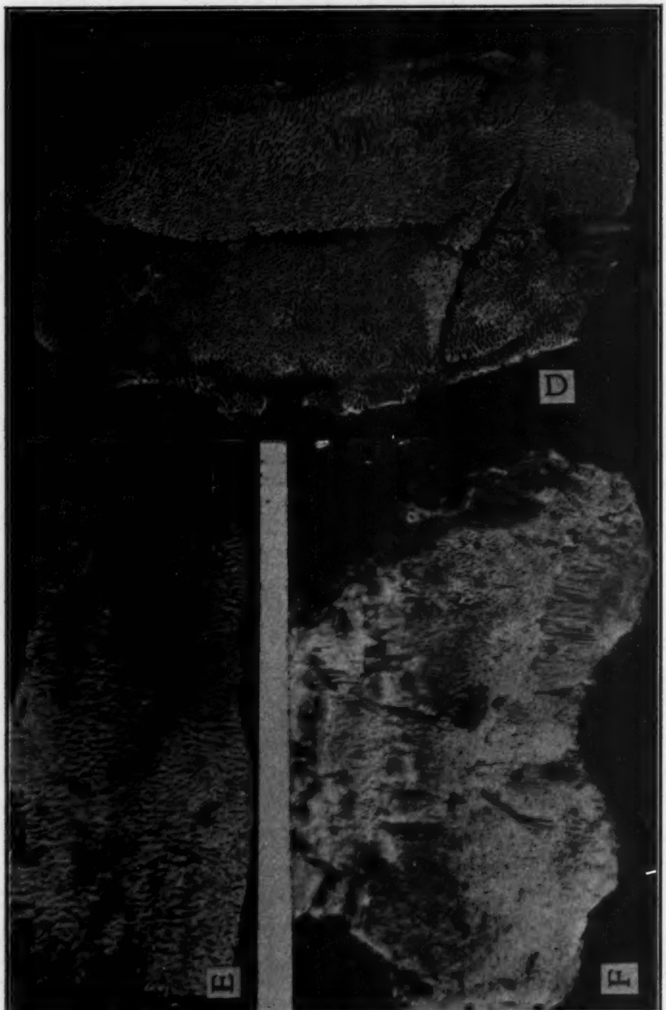

FIG. 2. D, *Poria illudens* × 2 (Lowe 2428); E, *Poria bombycina* × 2 (S. M. Pady); F, *Poria rubens* × 1 (Lowe 2392).

longis; poris rotundis vel demum daedaloideis vel sinuosis, quacumque superficies est inclinata, 3–4 singulis plerumque in uno mm., dissaepimentis demum tenuioribus, acie integra; clavis hyphatis modo numerosis modo absentibus; cystidiis raris et in hymenio immersis, tenuiter tunicatis, diametro 5–9 μ, forma haud dissimilis pedis; basidiis late clavatis, 10–15 × 4–6 μ; sporis hyalinis, levibus, late ovatis vel globosis, 2–4 × 2–3 μ; subiculo albo, in statu sicco parvatim fibrato et lentiore, ad 0.2 mm. crasso, ex hyphis laxe vel compactius intertextis, maiorem partem solidis, diametro 2–3 μ, saeptis nullis, rare ramosis, etiam cum hyphis non nullis tenuiter tunicatis et intricate ramosis, diametro 2–4 μ, fibulis minutis et obscuris, et cum premuntur, facile separabilibus; hyphis tramarum similibus, sed pallidis et luteis in hydrate kalico, arte contextis, et saeptis nullis.—In ligno coniferarum et aliquando deciduarum, specimen typicum prope Brandon, Vermont, a H. G. Eno collectum, et in herbario L. O. Overholtsii (n. 19193) conservandum. Id exemplum consimile est *Poriae versiporae* (Pers.) Rom., sed sporis minoribus et hyphis praecipuis non fibulatis.

Annual, effused up to 8 cm., leathery and moist when fresh, tough-corky when dry, readily or difficultly separable, without distinct odor or taste; margin narrow, fimbriate, concolorous with the pore surface; tubes up to 4 mm. long, their mouths cream to buff or somewhat yellowish, sometimes darkening somewhat on drying, dull or glistening, subangular, or becoming daedaloid or sinuous on inclined surfaces, averaging 3 to 4 per mm., the edges becoming thin, entire; hyphal pegs sometimes abundant, sometimes absent; cystidia seen only in the thinnest sections, rare, imbedded in the hymenium, thin-walled, 5–9 μ diameter, shaped like the foot of a stocking; basidia broadly clavate, 10–15 × 5–6 μ; spores hyaline, smooth, broadly oval to globose, 2–4 × 2–3 μ; subiculum white, fine-fibrous and rather soft when dry, up to 0.2 mm. thick, the hyphae loosely to rather compactly interwoven, mostly solid, 2–3 μ diameter, without cross walls, rarely branched, mixed with a small amount of thin-walled, sometimes intricately branched hyphae 2–4 μ diameter, with very inconspicuous clamps, separating readily by pressure; tramal hyphae pale yellowish in KOH, closely interwoven, thin-walled to solid, rarely branched, without cross walls, 2–3 μ diameter, separating readily on pressure.

On the wood of coniferous or less often of deciduous trees; type specimen collected on *Tsuga canadensis* (L.) Carr. at Brandon, Vt., by H. G. Eno and deposited in the Overholts Herbarium (n. 19193); known also from Warrensburg, N. Y., Lowe 2083, 2085, 2428, 2452, and Carlberg 48. The plant is very similar to *Poria versipora* (Pers.) Rom., but with smaller spores and without clamps on the predominant subiculum hyphae.

Poria lenta Overholts and Lowe, n. sp. (FIG. 1, A)

Annua, effusa ad 8 cm., mollis et valida, vel facile vel difficile separabilis, nec gustatu nec odore distincta; margine alba et byssina, vel angusta vel latiore; superficie pororum alba, in statu sicco cremea, leviter nitida; tubulis ad 2.5 mm. longis; poris rotundis vel aliquantum angulatis vel sinuosis quaecumque superficies est inclinata, 2–4 in uno mm.; dissaepimentis demum tenuioribus, acie integra; clavis hyphatis nullis, nullisque cystidiis; basidiis cylindratis vel late pyriformibus, 15–19 × 6–8 μ; sporis hyalinis, levibus, plerumque guttulatis, latis ovoideis vel subglobosis, 5–6 × 4–5 μ; subiculo albo, ad 0.1 mm. crasso, aliquando usque in substratum rhizomorpheis, mollibus et fibratis, ex hyphis rare ramosis, crasse tunicatis, diametro 2–4 μ, saeptis nullis, et, cum premuntur, non facile separabilibus, trama continuo; hyphis tramarum similibus sed diametro 1.5–2.5 μ.—In ligno coniferarum, specimen typicum in ligno *Tsugae canadensis* (L.) Carr. prope Warrensburg, New York a J. L. Lowe collectum (n. 1767) et in herbario L. O. Overholtsii (n. 24093) conservandum. Id exemplum consimile est *Poriae molluscae* (Pers.) Bres., sed sporis maioribus et hyphis non saeptatis.

Annual, effused up to 8 cm., soft and tough, easily or difficultly separable, without distinct taste or odor; margin white, mycelioid, narrow to rather wide; pore surface white, cream when dry, slightly glancing; tubes up to 2.5 mm. long, pores circular to somewhat angular or sinuous on inclined surfaces, averaging 2 to 4 per mm., the dissepiments becoming rather thin, the edge entire; hymenium without hyphal pegs; cystidia sometimes represented by broadly fusoid blunt organs 6–8 μ diameter; basidia cylindric to broadly pyriform, 15–19 × 6–8 μ; spores hyaline, smooth, usually with a large globule, broadly oval to subglobose, 5–6 × 4–5 μ; subiculum white, up to 0.1 mm. thick, sometimes with rhizomorphic strands extending into the substratum, soft and fibrous, the hyphae rarely branched, thick-walled, 2–4 μ diameter, without septa, difficultly separable by pressure; trama continuous with the subiculum, of similar hyphae but only 1.5–2.5 μ diameter.

On the wood of coniferous trees; type collected on *Tsuga canadensis* (L.) Carr. at Warrensburg, N. Y., Lowe 1767, and deposited in the Overholts Herbarium (n. 24093); known also from Warrensburg, Lowe 2450 and 2555, and from the Catskill Mts., N. Y. (C. H. Peck). The plant is similar to *Poria mollusca* (Pers.) Bres. but with larger spores and with non-septate hyphae.

Poria mappa Overholts and Lowe, n. sp.

Annua, interrupte effusa ad 10 cm. vel ultra, adnata, odore non distincta; margine alba, arachnoidea, vel angusta vel lata; superficie pororum alba, in statu sicco pallida et cremea vel sordida et lutea, haud nitida; tubulis bene

formatis saepe, priusquam nascitur hymenium, cerosis, in statu sicco fragilibus, ad 1 mm. longis, poris demum angulatis, 3 fere singulatis in uno mm., vel 2–4, dissaepimentis demum tenuibus, acie autem integra; hymenio ex trama distincto; cystidiis non visis; basidiis clavatis, 12–15 × 5–7 μ; sporis hyalinis, levibus, cylindratis, vel rectis vel leviter curvatis vel aliquando paene subfusiformibus, 7–12 × 2.5–3 μ; subiculo albo, ad 0.2 mm. crasso, in statu sicco molli, ex hyphis plerumque compacte intertextis, diametro 2.5–3.5 μ, tenuiter tunicatis vel solidis, modice ramosis, fibulatis et, cum premuntur, facile separabilibus; hyphis tramarum similibus, sed diametro 2–2.5 μ.—In ligno coniferarum, specimen typicum prope Enderby, British Columbia, a D. C. Buckman collectum et in herbario L. O. Overholtsii (n. 24445) conservandum. Id exemplum consimile est *Poriae reticulatae* (Pers. ex Fries) Cooke, sed poris maioribus et hyphis fibulatis.

Annual, interruptedly effused up to 10 cm. or more, adnate, without distinct taste or odor; margin white, arachnoid, narrow to wide; pore surface white, when dry pale cream or sordid yellowish, dull; tubes often becoming well-formed before being lined with the hymenium, soft and easily mashed when fresh, fragile when dry, up to 1 mm. long, the pores becoming angular, averaging three per mm. (two to four per mm.), the dissepiments becoming thin, edge entire; hymenium distinct from the subhymenial tissue; cystidia none; basidia clavate, 12–15 × 5–7 μ; spores hyaline, smooth, cylindric and straight to slightly curved or occasionally almost subfusiform, 7–12 × 2.5–3 μ; subiculum white, up to 0.2 mm. thick, soft when dry, the hyphae for the most part compactly arranged, 2.5–3.5 μ diameter, thin-walled to solid, moderately branched, with abundant clamps, readily separable under pressure; tramal hyphae similar but 2–2.5 μ diameter.

On the wood of coniferous trees; type collected at Enderby, British Columbia, Oct. 14, 1944, by D. C. Buckman (Overholts Herb. n. 24445) on *Thuja plicata* D. Donn. Known also from Newcomb, N. Y., Lowe 2312. The sporophore is somewhat similar to that of *Poria reticulata* (Pers. ex Fr.) Cooke but with larger pores and with clamped hyphae. The rot produced seems to be of the brown cubical type.

Poria rubens Overholts and Lowe, n. sp. (FIG. 2, F)

Annua, effusa ad 15 cm., cerosa, in statu sicco dura et fragilis, facile separabilis, nec gustatu nec odore distincta; margine angustiore, minuta strigosa vel implicita vel radiata-fibrata, et vel concolore vel albida; superficie pororum aurea, "Salmon-orange," et in aetate et in statu sicco remisse purpurea, "Russet-vinaceous"; tubulis ad 8 mm. longis, hydrate kalico breviter purpurascentibus; poris plus vel minus rotundis, 3 singulis plerumque in uno

mm., dissaepimentis demum tenuibus, acie integra vel alba-fimbriata; hymenio a trama distinctiore; cystidiis nullis; basidiis anguste clavatis, 13–19 × 5–6 μ; sporis hyalinis, levibus, oblongis vel ita brevibus, ut oblongae-ellipsoideae videantur, 3.5–5 × 2–2.5 μ; subiculo ex colore dissaepimentorum paene ad colorem sordide album mutante, ad 0.5 mm. crasso, cum parvis sub microscopico granulis, ex hyphis rare ramosis, vel crasse vel tenuiter tunicatis, rare fibulatoriis, diametro 3–4 (6) μ, et, cum premuntur, facile separabilibus; hyphis subiculi neque dissimiles sunt hyphae tramae.—In ligno coniferarum, specimen typicum prope Owl Creek, British Columbia, a J. R. Hansbrough collectum (n. 40660) et in herbario L. O. Overholtsii (n. 13984) conservandum.

Annual, effused up to 15 cm., soft and waxy when fresh, hard and brittle when dry, readily separable, taste and odor not distinctive; margin rather narrow, minutely strigose or matted or radiately fibrous, concolorous or paler to whitish; surface of the pores orange, "Salmon orange," in older portions and on drying dull purplish, or "Russet-vinaceous"; tubes up to 8 mm. long, briefly lavender in KOH; pores more or less regularly angular, averaging 3 per mm., the dissepiments becoming thin, edge entire or sometimes white-fimbriate; hymenium rather distinct from the tramal tissue; cystidia none; basidia narrowly clavate, 13–19 × 5–6 μ; spores hyaline, smooth, oblong or so short as to appear oblong-ellipsoid, 3.5–5 × 2–2.5 μ; subiculum shading from dissepiment color to nearly white next the substratum, up to 0.5 mm. thick, with much fine granular matter in microscopic section, the hyphae rarely branched, thick- or thin-walled, with rare clamps, 3–4 (6) μ diameter, readily separated by pressure; tramal tissue similar.

On the wood of coniferous trees; type collected at Owl Creek, British Columbia, by J. R. Hansbrough (n. 40660), June 15, 1930, and deposited in Overholts Herbarium as n. 13984; known also from New Hampshire (D. H. Linder, Herb. Farlow), from New York, Lowe 2392, from Michigan (D. V. Baxter), and from Lake Timagami, Ontario (S. M. Pady).

Poria carnicolor Baxter appears to be very similar except for its larger spores, 5.5–7 × 2–3 μ.

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THE ACTION OF SULFONAMIDES ON CERTAIN FUNGI PATHOGENIC TO MAN [1]

Frederick T. Wolf [2]

The widespread use of sulfonamides in the treatment of infections of bacterial origin has suggested the possibility of using these compounds in the treatment of mycotic infections. There is probably no fungus infection against which one or more of the sulfa drugs has not been tried.

The results of administration of sulfonamides by the oral route have been more successful in cases of actinomycosis than with other mycotic infections. A considerable number of cases of this disease have been rapidly and completely cured following sulfonamide therapy (Walker **1938**; Miller and Fell **1939**; Dorling and Eckhoff **1940**; Ogilvie **1940**; Dobson, Holman and Cutting **1941**; Mitchell **1942**; Benbow, Smith and Grimson **1944**). Reports of cures following the oral administration of sulfonamides in a few cases of Madura foot (Dixon **1941**), torulosis (Reeves, Butt and Hammack **1941**; Marshall and Teed **1942**), blastomycosis (Schroeder **1940**), moniliasis (Van Bree **1941**), sporotrichosis (Navarro-Martin **1940**), epidermophytosis (Pfalzgraf **1941**) and various bronchopulmonary mycoses (de Almieda and Lacaz **1942**) have been recorded. Attempts to cure histoplasmosis (Moore and Jorstad **1943**) and primary pulmonary coccidioidomycosis (Goldstein and McDonald **1944**) by sulfonamides have failed. In consideration of these clinical studies, it should be pointed out that the number of cases is small, the basis of treatment has been largely empirical, and too often sulfonamide treatment has been instituted in advanced cases only when more accepted means of therapy have failed.

The rational use of sulfonamides in the therapy of mycotic in-

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fections must in general depend upon evaluation of the action of these compounds upon cultures of fungi *in vitro*. The fungistatic action of the sulfonamides was discovered by Fourneau, Tréfouël, Tréfouël, Nitti and Bovet (**1936**), who noted that the growth of *Aspergillus niger* was greatly delayed by the addition of sulfanilamide to the culture medium. Cutting and Gebhardt (**1941**), while studying the effect of sulfanilamide, sulfathiazole, and sulfadiazine upon *Actinomyces hominis,* found that sulfanilamide in a concentration of 50 or 100 mg. per cent checked the growth of this organism completely. Both sulfathiazole and sulfadiazine, however, were more effective than sulfanilamide in similar concentrations.

Lewis and Hopper (**1941**) studied the action of sulfanilamide, sodium sulfapyridine, sulfathiazole, sodium sulfathiazole, sulfadiazine and sodium sulfadiazine upon *Trichophyton gypseum* and *Monilia albicans*. They summarize their results as follows: "None of the compounds tested had any demonstrable effect on the growth of *Monilia albicans*. With *Trichophyton gypseum,* however, on examination after two weeks, some limitation of growth was seen to have been caused by all the compounds and complete retardation of growth had been accomplished by means of sulfanilamide in a dilution of one per cent. After three weeks, minute colonies began to appear."

These results were confirmed and extended by the work of Dimond and Thompson (**1942**) upon *Trichophyton gypseum* and *T. purpureum*. Experiments in which spores were suspended in solutions of various sulfonamides for various periods, and subsequently washed and inoculated upon an agar medium, indicated no significant signs of injury as a result of this treatment, since the cultures grew normally after the removal of the drug. The action of sulfanilamide was thus clearly shown to be fungistatic rather than fungicidal in nature. Further experiments demonstrated that sulfanilamide was far more effective than sulfapyridine, sulfathiazole, sulfaguanidine, or sodium sulfadiazine in inhibiting growth of these fungi, and measurements of growth rates showed that the fungistatic effect was amenable to interpretation as an extension of the lag phase of the growth curve. The fungistatic effect of sulfanilamide was much more pronounced on a peptone-free me-

dium, indicating that peptone presumably contains anti-sulfonamide factors.

Noojin and Callaway (**1943**) have reported upon the action of seven different sulfonamides on cultures of *Blastomyces dermatitidis*. Sulfadiazine and sulfanilamide were the most effective compounds tested. The concentrations required for fungistasis, however, were well above the limit which can be maintained in the blood and tolerated by the patient, so that the most effective clinical use of the sulfonamides in cases of blastomycosis must be restricted to local application. These investigators (Noojin and Callaway **1944**) have also determined the action of nine sulfonamides upon cultures of *Sporotrichum schenckii*. Sulfanilamide and sodium sulfapyridine were the most effective, but again, as in the case of *Blastomyces dermatitidis*, high concentrations of the compounds were required to inhibit growth completely.

Senturia and Wolf (**1945**) studied the action of sulfonamides applied to cultures of fungi isolated from cases of otomycosis. The growth of *Aspergillus fumigatus, A. niger, A. glaucus, A. Sydowi* and *Mucor corymbifer* upon plates of Sabouraud's agar is markedly inhibited by sulfanilamide, but not by sulfathiazole, sulfadiazine, sulfaguanidine, or sulfamerazine, when the quantity of the drug approximates 20–30 mg. per culture. *Monilia albicans*, however, is unaffected by any of these sulfonamides, confirming the findings of Lewis and Hopper (**1941**).

As a result of these studies upon the fungi of otomycosis, further work concerning the effect of sulfonamides upon several other fungi of clinical importance was done. The present report is concerned with the findings of these studies.

MATERIALS AND METHODS

The fungi studied were as follows: *Candida* (*Monilia*) *albicans, C. krusei, C. tropicalis, C. parakrusei, C. pseudotropicalis, Cryptococcus neoformans, Epidermophyton floccosum, Trichophyton mentagrophytes* (*T. gypseum*), *T. rubrum, Microsporum gypseum, M. canis, Hormodendrum pedrosoi, H. compactum, Phialophora verrucosa, Sporotrichum schenckii* and *Monosporium apiospermum*. All cultures were obtained through the courtesy of Dr.

N. F. Conant, Department of Bacteriology, Duke University School of Medicine.

The fungi were grown on Sabouraud's agar in an incubator maintained at 37° C. The sulfonamides tested were sulfanilamide, sulfathiazole, sulfadiazine and sulfaguanidine. The drugs were applied in a manner similar to that previously employed with fungi isolated from cases of otomycosis (Senturia and Wolf **1945**).

For each of the sixteen organisms, one plate was inoculated to serve as a control. Other plates, inoculated at the same time, were immediately dusted with the powdered sulfonamide, the amount applied approximating 20 mg. per plate. Because of the possibility of variation in the results, each experiment was done several times.

The time allowed for incubation of the cultures prior to evaluation of the drug varied with the organism being tested. In the case of *Cryptococcus* and the various species of *Candida,* yeast-like organisms which grow very rapidly, a period of 3–5 days was sufficient. The remaining mycelial organisms grow more slowly, so that a period of two weeks was allowed.

RESULTS

Examination of the plates at the end of the stated periods of incubation disclosed great differences in the action of the various drugs upon the growth of a particular organism, and also differences in the growth responses of different fungi to a single sulfonamide. In general it appeared that the sulfonamides, in the dosage applied, either allowed the fungi to grow at a rate approximating that of the controls, or else inhibited their growth practically completely. In was therefore possible to segregate the fungi into those susceptible and those non-susceptible to the action of a particular sulfonamide.

Sulfanilamide was the only one of the sulfonamides tested which showed appreciable fungistatic activity. Some of the plates to which sulfanilamide was applied showed no macroscopically visible growth whatever at the end of a two week period. It was found that sulfanilamide is very markedly fungistatic to *Trichophyton mentagrophytes, T. rubrum, Epidermophyton floccosum, Microsporum canis, M. gypseum* and *Sporotrichum schenckii.* Sulfa-

nilamide has no definite fungistatic action, however, upon *Candida albicans, C. krusei, C. tropicalis, C. parakrusei, C. pseudotropicalis, Cryptococcus neoformans, Monosporium apiospermum, Hormodendrum pedrosoi, H. compactum* or *Phialophora verrucosa.*

Sulfathiazole, sulfadiazine and sulfaguanidine are not appreciably fungistatic toward any of the organisms tested. No growth-inhibitory effect, or at most a very slight one, was obtained with any of these compounds. If the assumption be granted that *in vitro* tests provide a valid means of determining the effectiveness of chemotherapeutic agents for clinical use, the results indicate that sulfonamide treatment of moniliasis, torulosis, chromoblastomycosis and the type of maduromycosis due to *Monosporium apiospermum* would be unsuccessful.

APPENDIX

Since the completion of the experiments mentioned above, a report by Keeney, Ajello and Lankford (**1944**) concerned with the action of sodium sulfathiazole, sodium sulfadiazine and sodium sulfamerazine upon pathogenic fungi has come to our attention. In addition to the organisms with which we were concerned, Keeney *et al.* have also studied *Microsporum audouini, M. felineum, Blastomyces dermatitidis, Coccidioides immitis, Histoplasma capsulatum* and *Actinomyces hominis.*

These investigators have employed a technique which eliminates the effect of anti-sulfonamide factors in the nutrient media. In our own study, not employing such refinements of technique, we have nevertheless been able to demonstrate that at least one sulfonamide, namely sulfanilamide, is fungistatic in spite of the presence of known anti-sulfonamide factors in the medium. If sulfonamides are to be of value clinically, they must overcome the anti-sulfonamide factors present in tissue fluids.

Keeney *et al.* have shown that the sodium salts of the sulfonamides may be fungicidal to *Microsporum audouini, Phialophora (Hormodendrum) pedrosoi* and *Histoplasma capsulatum* if a sufficiently high concentration is employed. These workers conclude that the results obtained with the sodium salts of the sulfonamides are not sufficiently impressive to warrant clinical trial, except for sodium sulfamerazine in the case of chromoblastomycosis and so-

dium sulfathiazole in treatment of histoplasmosis. It is to be hoped that further *in vitro* studies, and clinical trials of substances found to be superior under these conditions, may eventually result in better methods of therapy of mycotic diseases.

SUMMARY

Sulfanilamide is very fungistatic to *Trichophyton mentagrophytes, T. rubrum, Epidermophyton floccosum, Microsporum canis, M. gypseum* and *Sporotrichum schenckii, in vitro.*

Sulfanilamide has no definite fungistatic action *in vitro* upon *Candida albicans, C. krusei, C. tropicalis, C. parakrusei, C. pseudotropicalis, Cryptococcus neoformans, Monosporium apiospermum, Hormodendrum pedrosoi, H. compactum* and *Phialophora verrucosa.*

Sulfathiazole, sulfadiazine and sulfaguanidine are not appreciably fungistatic toward any of these organisms under *in vitro* conditions.

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LITERATURE CITED

de Almieda, F. & C. S. Lacaz. Micoses broncopulmonares. Comp. Melhoramentos de Sao Paulo. 1942.

Benbow, E. P., Jr., D. T. Smith & K. S. Grimson. Sulfonamide therapy in actinomycosis; two cases caused by aerobic partially acid-fast *Actinomyces.* Am. Rev. Tuberc. **49**: 395, 1944.

Cutting, W. C. & L. P. Gebhardt. Inhibitory effects of sulfonamides on cultures of *Actinomyces hominis.* Science **94**: 568. 1941.

Dimond, N. S. & K. W. Thompson. The effect of sulfonamide drugs on Trichophytons *in vitro.* J. Invest. Dermatol. **5**: 397. 1942.

Dixon, J. M. Sulfanilamide therapy in Madura foot. Virginia Med. Monthly **68**: 281. 1941.

Dobson, L., E. Holman & W. Cutting. Sulfanilamide in the therapy of actinomycosis. J. A. M. A. **116**: 272. 1941.

Dorling, G. C. & N. L. Eckhoff. Chemotherapy of abdominal actinomycosis. Lancet **2**: 707. 1940.

Fourneau, E., J. Tréfouël, Mme. J. Tréfouël, F. Nitti & D. Bovet. Action du para-aminophenylsulfamide sur les moisissures. C. R. Soc. Biol. **122**: 652. 1936.

Goldstein, D. M. & J. B. McDonald. Primary pulmonary coccidioidomycosis. J. A. M. A. **124**: 557. 1944.

Keeney, E. L., L. Ajello & E. Lankford. Studies on common pathogenic fungi and on *Actinomyces bovis.* II. *In vitro* effect of sulfonamides. Bull. Johns Hopkins Hospital **75**: 393. 1944.

Lewis, G. M. & M. E. Hopper. Effect of sulfanilamide and its derivatives on fungi. Preliminary *in vitro* experiments. Arch. Dermatol. Syphilol. **44**: 1101. 1941.

Marshall, M. & R. W. Teed. *Torula histolytica* meningoencephalitis. Recovery following bilateral mastoidectomy and sulfonamide therapy: Preliminary report. J. A. M. A. **120**: 527. 1942.

Miller, E. M. & E. H. Fell. Sulfanilamide therapy in actinomycosis. J. A. M. A. **112**: 731. 1939.

Mitchell, H. S. Sulfapyridine in actinomycosis. Canadian Med. Assn. Jour. **46**: 584. 1942.

Moore, M. & L. H. Jorstad. Histoplasmosis and its importance to otorhinolaryngologists: A review with report on a new case. Ann. Otol. Rhin. Laryng. **52**: 779. 1943.

Navarro-Martin, A. Sporotrichosis; sulfanilamide therapy, with report of case. Actas Dermo-Sif. **32**: 271. 1940.

Noojin, R. O. & J. L. Callaway. Action of sulfonamide compounds on *Blastomyces dermatitidis in vitro.* Arch. Dermatol. Syphilol. **47**: 620. 1943.

Noojin, R. O. & J. L. Callaway. Effectiveness *in vitro* of sulfonamide compounds on *Sporotrichum schenki.* Arch. Dermatol. Syphilol. **49**: 305. 1944.

Ogilvie, W. H. Abdominal actinomycosis treated with sulphapyridine. British Med. Jour. **2**: 254. 1940.

Pfalzgraf, C. Prontosil-Alkohol-Azeton-Lösung zur Behandlung der Epidermophytie und nässen der Wundekzeme. München. Med. Wochenschr. **88**: 399. 1941.

Reeves, D. L., E. M. Butt & R. W. Hammack. Torula infection of the lungs and central nervous system. Arch. Int. Med. **68**: 57. 1941.

Schroeder, C. B. Über die Heilung eines Falles von maligner Blastomykose. Arch. f. Schiffs- u. Tropen Hyg. **44**: 477. 1940.

Senturia, B. H. & F. T. Wolf. Treatment of external otitis II. Action of sulfonamide compounds on fungi isolated from cases of otomycosis. Arch. Otolaryngol. **41**: 56. 1945.

Van Bree, R. S. Moniliasis: sulfapyridine treatment. J. Mich. State Med. Soc. **40**: 197. 1941.

Walker, O. Sulphanilamide in the treatment of actinomycosis. Lancet **1**: 1219. 1938.

AN UNDESCRIBED SPECIES OF ELSINOË FROM MYSORE

M. T. Thirumalachar

(with 7 figures)

The genus *Elsinoë* Raciborski includes several well known parasites causing the scab or anthracnose disease of economic plants. The genus was founded by Raciborski (**1900**) to accommodate the fungus on *Conavalia gladiata* collected in Java. As a preliminary step in the course of a detailed monographic account of the genus *Elsinoë,* Jenkins and Bitancourt (**1941**) have given revised descriptions of the diagnostic characters of the genus and its conidial stage *Sphaceloma* de Bary, according to which the genera *Isotexis* Sydow and *Plectodiscella* Woronichin are treated as synonyms of *Elsinoë*.

In India the conidial stage of the sour-orange scab, *Sphaceloma Fawcetti* Jenkins, was collected as early as 1867 in Bengal, though this was not discovered until 1933 when Jenkins and Fawcett (**1933**) examined herbarium material of *Citrus medica* deposited at the Arnold Arboretum. Kar and Saha (**1943**) recently described the remedial measures for controlling the scab of pumelo (*Citrus grandis* Osbeck) in Bengal. Jenkins (**1936**) also records this fungus on the fruits of *Hesperethusa crenulata,* in Bengal again, the host being a distant relative of the *Citrus* group. The identification was based on material sent to Dr. W. T. Swingle by the curator of the Royal Botanical Gardens, Calcutta. It is apparent from the above account that only *Sphaceloma Fawcetti,* the conidial stage of the sour-orange scab, has been recorded in India and that the ascigerous stage for this or any other species of *Elsinoë* previously has not been reported.

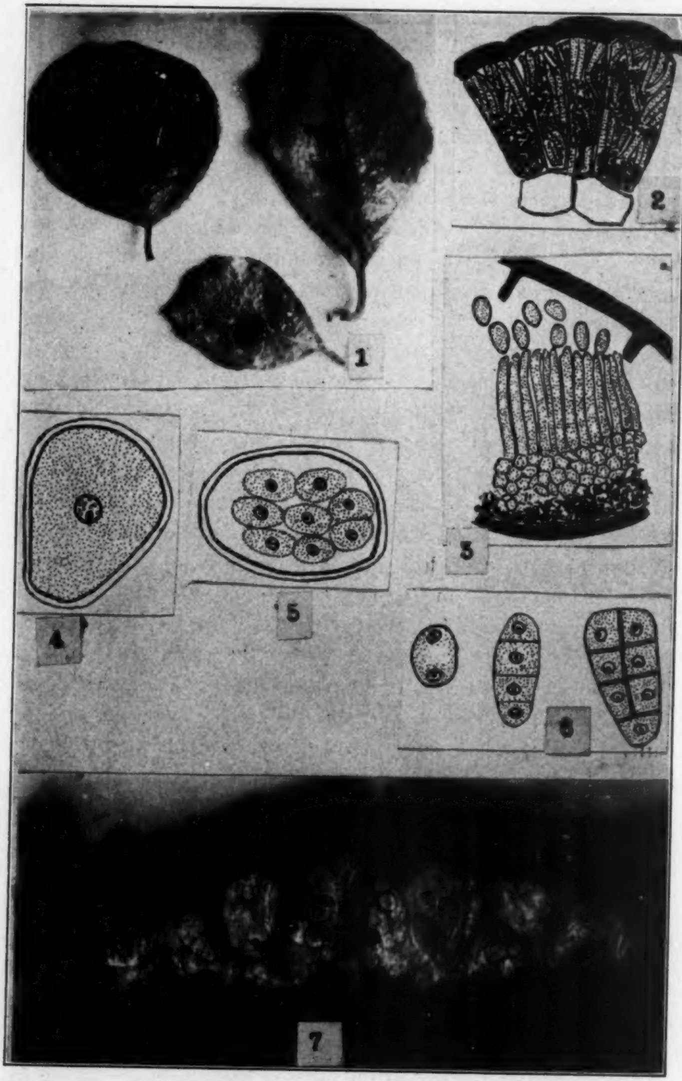
In the course of collecting the fungous flora around Nandi Hills, Mysore State, the writer came across an *Elsinoë* on *Scutia myrtina* Kurz., a member of the Rhamnaceae, which appeared to be undescribed. Further detailed studies undertaken by the writer con-

firmed this surmise. The fungus differed entirely from *Elsinoë Hansfordii* Jenkins & Bitancourt (1942), described on the same host species from Uganda, as well as from any other species so far known. For microscopic examination the material was fixed in formalin-acetic-alcohol, and the microtome sections that were cut were stained with Heidenhain's iron-alum haematoxylin with orange G in clove oil as counter stain.

The infection spots, which are mostly found on the leaves and petioles and very rarely on tender shoots, first appear as tiny black specks gradually expanding into a patch. There is no sign of any hypertrophy or formation of blistered warts as in the case of *Elsinoë Hansfordii*. On the other hand, the ascomata is epiphyllous forming a jet black epithecium composed of dark hyphal cells and host cells. The affected regions are slightly thicker than the non-infected portions. The *Sphaceloma* stage is not found in association with young ascomata and was seen first only in the culture obtained from the ascospores. Further search among the infected plants revealed that the *Sphaceloma* stages are of rather rare occurrence. The leaf lesions in such cases are yellowish brown, amphigenous and erumpent. Sections through the acervuli indicate that the fundaments of the sori are first organized by the concentration of the hyphae within the epidermis (FIG. 2). Very soon, a palisade layer of conidiophores is differentiated and these cause the rupture of the upper wall of the epidermis and the cuticle. The sori are thus intraepidermal and the conidiophores abstrict ovate to globoid conidia in succession (FIG. 3). The conidiophores are cylindric, 30–50 μ long, somewhat tapering at the ends and thin-walled. The conidia are ovate subglobose, hyaline, thin walled, one-celled and measure 8–10 × 4–5 μ.

Sections through the young ascomata also reveal that the fundaments of the sori are organized by the concentration of dark hyphal cells within the upper epidermal cells and thus are intraepidermal in origin. The asci are subglobose to spherical, embedded within the stroma, and disposed in two to three layers (FIG. 7). Microconidia have not been observed as yet.

The studies on the sexual life cycle of the fungus are as yet incomplete. The young ascus is spherical, double-walled, and shows a large fusion nucleus (FIG. 4). By three successive free nuclear



FIGS. 1–7. *Elsinoë Bitancourtiana*

divisions an 8-nucleate ascus is produced, the nuclei being disposed approximately equidistant from one another. Following the differentiation of cleavage furrows, eight young ascospores are produced (FIG. 5). These are at first spherical and uninucleate. The nucleus within each spore divides followed by periclinal wall formation. At this stage the ascospores appear to be filamentous showing three transverse septa. By the initiation of anticlinal divisions in the upper three cells, the ascospore becomes muriform (FIG. 6). The mature ascospores are therefore cuneate, being broader at the apex than at the base, multicellular, muriform, thin walled, and measure 25–31 × 12–15 μ.

Studies of the fungus were also made in artificial cultures. For obtaining the cultures a suspension of ascospores in sterile distilled water was made on slides and allowed to dry. Transfers of these ascospores were made with a dry sterilized needle to agar slants. Colored gummy growth of the fungus producing the *Sphaceloma* stage led the writer to search for the conidial stage in nature also. Comparisons in shape and measurements between the conidia produced in culture and those obtained by natural infection indicated that they were identical.

As to the identity of the species of *Elsinoë* under study, it is apparent that there is considerable difference between it and *E. Hansfordii.* Although both occur on the same host, *E. Hansfordii* causes malformations of the host tissue in the form of gall-like excrescences. The presence of a black epithecium, so characteristic of the present species, is absent in *E. Hansfordii.* Mature ascospores have not been observed for *E. Hansfordii* so no comparison can be made with respect to this feature. The writer proposes to present the fungus described in this study as a new species and the name *Elsinoë Bitancourtiana,* in honor of Dr. A. A. Bitancourt, Sao Paulo, Brazil, who has considerably advanced our knowledge of the group, is proposed.

Elsinoë Bitancourtiana Thirumalachar sp. nov.

Plures infectionis maculas producens in foliis, petiolis, sed raro in culmis teneribus, dispersas, ut plurimum epiphyllas, gradatim crescentes atque simul confluentes, circulares ad irregulares, 3–5 mm. in diam., aliquantulum elevatas supra foliorum faciem, numquam hypertrophiam producentes. Asco-

mata epiphylla, intraepidermalia atra ob epithecium structum hyphis obscuris atque cellulis plantae parasitatae; asci bis vel ter-seriati, hyalini, tenui pariete praediti, intus stromati infixi, ovati ad sphaericos, 38–55 × 30–40 μ, 8-spori; ascosporae ellipsoideae, latiores ad apicem quam ad basim, tenuibus parietibus praeditae, initio 4-septatae, postea muriformes ob efformatos muros verticales, magnitudinis 25–31 × 13–15 μ. Infectionis maculae in *Sphacelomatis* statu amphigenae, luteo-brunneae, haud hypertrophiatae, erumpentes atque pulverulentae. Acervuli intraepidermales, conidiophoris in serialibus vallatis dispositis atque epidermatis superiorem faciem erumpentibus, saepe continui ob coalescentiam; conidiophori quater vel sexies longitudine majores quam latitudine, cylindrici, acuti in apice, ad 30–50 μ longi, acrogena successione efformates, conidia hyalina; conidia ovata ad sphaerica, tenuiter parietata, magnitudinis 8–10 × 4–5 μ.

In foliis atque petiolis sed raro in culmis teneribus *Scutiae myrtinae* Kurz., Nandi Hills, Mysore State, 16–11–1944, leg. M. J. Thirumalachar (Type), Burudalbore, Hassan District, 26–4–1945, and Jalahalli, Bangalore, 18–10–1944.

Infection spots numerous, on leaves and petioles and rarely on tender shoots, circular to irregular, 3–5 mm. in dia., enlarging and becoming confluent with one another, jet black on account of the epithecium composed of dark hyphae and host cells, never hypertrophied, showing pustulate appearance on the surface. Ascomata epiphyllous, intraepidermal, black on account of the epithecium, asci two to three layered, embedded within the stroma, subglobose to spherical, double-walled, 38–55 × 30–40 μ and 8-spored; ascospores ellipsoidal, broader at the apex, thin walled, four-septate in the early stages, later on becoming muriform due to the formation of vertical septations and measuring 25–31 × 13–15 μ. Infection spots of the *Sphaceloma* stage amphigenous, yellowish brown, erumpent and not hypertrophied; sori intraepidermal with palisade layers of conidiophores rupturing the upper wall of the epidermis; acervuli often coalescing to form a continuous layer; conidiophores cylindric, 30–50 μ long, developing acrogenously in succession hyaline conidia. Conidia ovate to spherical, one-celled, thin walled, hyaline, measuring 8–10 × 4–5 μ.

On living leaves of *Scutia myrtina* Kurz., Nandi Hills, Mysore State, 16–11–1944, leg. M. J. Thirumalachar (Type), Burudalbore, Hassan District, 26–4–1945, and Jalahalli, Bangalore, 18–10–1944. Type deposited in the Herb. Crypt. Ind. Orient., New Delhi, in the Imperial Mycological Institute, Kew, England, and in the Instituto Biologico, Sao Paulo, Brazil.

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LITERATURE CITED

Jenkins, A. E. 1936. A *Sphaceloma* on fruit of *Hesperethusa crenulata,* a remote *Citrus* relative from India. Phytopathology **26**: 71–73.

Jenkins, A. E. & A. A. Bitancourt. 1941. Revised description of *Elsinoë* and *Sphaceloma.* Mycologia **33**: 338–340.

——. 1942. *Elsinoë* in Uganda. Mycologia **34**: 318–321.

Jenkins, A. E. & H. S. Fawcett. 1933. Records of *Citrus* scab mainly from herbarium specimens of the genus *Citrus* in England and the United States. Phytopathology **23**: 475–482.

Kar, P. C. & J. C. Saha. 1943. Controlling fruit scab of pumelo *Citrus grandis* Osbeck (*C. decumana* L.). Science & Culture **8** (10): 422–423.

Raciborski, M. 1900. Parasitischen Algen und Pilzen Javas, t. **1** (39 pp.) and **2** (46 pp.). Batavia.

EXPLANATION OF FIGURES

FIG. 1. Photograph of infected leaves × about natural size.

FIG. 2. Organization of the intraepidermal sorus of *Sphaceloma* × 800.

FIG. 3. Section through an acervulus showing the conidiophores and conidia × 800.

FIG. 4. Ascus with fusion nucleus × 800.

FIG. 5. Ascus with 8 immature ascospores × 800.

FIG. 6. Stages in the development of the muriform ascospore × 1800.

FIG. 7. Photomicrograph showing the asci with ascospores within the stroma × 500.

NOTES AND BRIEF ARTICLES

A Correction

In the article A New Species of Lysurus, Mycologia **37**: 782. 1945, the figures 5 and 6 are reversed. Number 5 shows the outer side of the tip of an arm and no. 6 the inner.—W. C. Coker.

Russula inconstans Murrill

This was published in Lloydia **8**: 266. 1946 as a new Florida species. Miss Burlingham writes me that she used this name in Mycologia, 1936 for a new species from Oregon. I therefore propose for my Florida plant the new name **Russula subinconstans** Murrill.—W. A. Murrill.

Inocybe hebelomoides Murrill

Through an unaccountable error this species was published twice, first in Proc. Fla. Acad. Sci. **7**: 2 and 3. 121. 1944, and again in Jour. Fla. Acad. Sci. **8**: 2. 188. 1945. The descriptions are identical and refer to the same herbarium material.—W. A. Murrill.

Dr. Jakob E. Lange, 1864–1942

A letter from Morten Lange to Prof. L. R. Hesler a short time ago contained the information that Dr. Lange died "at the New Year, 1942." In his death our Society has lost one of its most distinguished members. Many of us knew Dr. Lange personally as a result of his visits to the United States, and treasure our memories of collecting trips with him in search of fungi. Those interested in the agarics, Dr. Lange's specialty, feel that his passing represents the greatest loss that could come to their field of interest at the present time. Morten stated that had his father been

alive during the last days of the war he would have been in constant danger. Mrs. Lange passed away in 1943. A more detailed biographical sketch will appear in MYCOLOGIA in due time.—ALEXANDER H. SMITH.

A NEW SPECIES OF HYDROPUS (KÜHN.) SING. (AGARICALES)

Hydropus is a grouping proposed by Kühner and given the rank of a genus by Singer. It contains several closely related species easily recognizable under the microscope, and after some experience also in the field. In addition to the species formerly indicated for this genus, I have recently discovered a sub-tropical species closely allied to *H. Sabalis* Sing. which is white and grows likewise on *Sabal palmetto*. The new species here named *H. frater-niger* (the black brother) grows exclusively on dead leaf-petioles and in detritus between them or on wooden matter beneath them, always of *Sabal palmetto,* in low hammock vegetation. It differs from the other *Sabal*-inhabiting species in being black instead of white. It is closest to the bispored form of *Hydropus marginellus* (Pers. *ex* Fr.) Sing. from which it differs in being darker colored, astriate and later sulcate on the pileus, by never becoming depressed except in dried condition, in having pallid white lamellae which are more distinctly decurrent-descendant, and in the constantly unequal stipe (which tapers downward). It is also slightly smaller in its general measurements if average specimens are compared.

Hydropus frater-niger Sing. spec. nov. Pileo subnigro, manente aterrimo in centro, ad marginem subpallente in vetustis et in siccis, convexo, subumbonato vel umbonato, numquam depresso nisi in exsiccatis ad ipsum discum, levi sed ad marginem demum sulcato, vix striato in plurimis, brevissime striato in exsiccatis, 6–9 mm. lato; epicute e dermatocystidiis versiformibus, inflatis, subvesiculosis vel late fusoideis, saepe subampullaceis, ascendentibus vel saepius erectis corticem subhymeniformem dense continuam efformantibus, intus succo e pigmento dissoluto umbrino repletis consistente; hypodermio ex hyphis repentibus, subparallelis, item coloratis, elongatis consistente; nequidem gelatinascente. Lamellis albidis vel albis, mediocriter latis (1.5 mm. latis), moderate distantibus (18 fere lamellis integris praesentibus), descendentibus, demum subhorizontalibus sed semper distincte decurrentibus; sporis hyalinis, membrana levi amyloidea instructis, depressione suprahilari praeditis vel applanatione tantum gaudentibus, 8.5–9.5 × 5–5.5 μ; basidiis 28–31 × 6.5–7 μ, omnibus bisporis; cheilocystidiis dermatocystidiis pilei simillimis. Stipite

griseo, vel griseo ad basin et albo ad apicem, interdum minutissime albo-pruinoso ad apicem e dermatocystidiis stipitis, constanter attenuatis basin versus, levi, pruina excepta glabro, 21–22 × 1–1.5 mm. Carne exigua; odore nullo; sapore haud notato; hyphis tramatis haud amyloideis, fibulatis; tramate lamellarum ex hyphis plerumque filamentosis, subregulariter dispositis consistente. Ad truncos palmarum tantum (*Sabal palmetto*) vivarum gregatim in dumetis palustribus subtropicalibus Floridae meridionalis. Typus (*Singer, F643,* FH) in Highlands Hammock State Park, Highlands County collectus erat.

R. SINGER.

TIME SAVING IN THE PREPARATION OF CORN MEAL AGAR AND IN THE IDENTIFICATION OF YEAST-LIKE FUNGI

I

Ajello [1] recommends the use of a "Silex Type" coffee maker with a Cory glass filter rod in order to save time in the preparation of corn meal agar. This method has the advantage of using a simple device that may be at hand in most kitchens. The disadvantage is that the mixture has to be passed and repassed at least eight times, and that the extraction of the corn meal takes place at a temperature exceeding substantially the 60° C. of the original method.

I have been using for years another method of reducing the time affecting only the modus of filtration. Twelve and one-half grams of yellow corn meal in 300 ml. of water are heated in a water bath of 60° C. for an hour, then poured into a porcelain filter containing Whatman filter paper No. 3. A suction pump attached to the water faucet draws a clear filtrate within a few minutes. The volume of the extract is measured, brought back to 300 ml. and added to the amount of agar needed (3.8 gm. of the prewar quality of Bacto agar, 3.0 gm. of the new agar). This is autoclaved at 15 lbs. pressure for 15 minutes in order to dissolve the agar, again filtered as described above and filled in tubes. These are autoclaved at 15 lbs. pressure for 15 minutes before they are slanted.

This method was checked repeatedly with corn meal agar prepared according to the original method. The results were the same. However, the preparation time has been reduced to two and a half hours.

[1] Ajello, L., A simple method for preparing corn meal agar, Mycologia **37**: 636–637, (Sept.-Oct.) 1945.

II

I have been using slants instead of Petri dishes for the identification of yeast-like fungi. The platinum needle inoculated from a colony is stabbed between the slanted agar and the wall of the tube. *Candida albicans* develops numerous filaments and quite a number of chlamydospores at room temperature (25° C.) within 24 hours. Since the stab culture just described develops near to the wall of the tube, filaments as well as chlamydospores are easily observed with the help of the low power lens.

The original method of searching for the chlamydospores in a Petri dish takes more time and may lead to contamination of the culture.

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* Dr. Bernhardt died suddenly, Feb. 27, 1946—Editor.

NOTICE

Please communicate to the Secretary, **at once**, any change of address.

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